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Large Masonry Arches on a Swiss Mountain Railway

By J. C. Van Langendonck*

In Engineering News, Dec. 25, 1913, p. 1294, there appeared a brief article describing the Swiss railway now under construction from Chur to Arosa and illustrating two of the large concrete arches now under construction. The accompanying cuts show some further views of these handsome bridges and illustrate particularly well the types of falsework used in continental practice.

The meter-gage Chur-Arosa adhesion railway is a branch of the Swiss Federal Railway System. The line, which will be opened for the summer season of 1915, has a length of about 10 mi. It starts at Chur (altitude 1913 ft.), the capital of the Grison Canton, and follows the carriage road along the River Plessur, as far as Sassal, and then ascends along the right side or sunny aspect of the Schanfigg Valley as far as Langwies, where it crosses over the left side of the valley and reaches the terminal station Arosa at an altitude of 5729 ft.

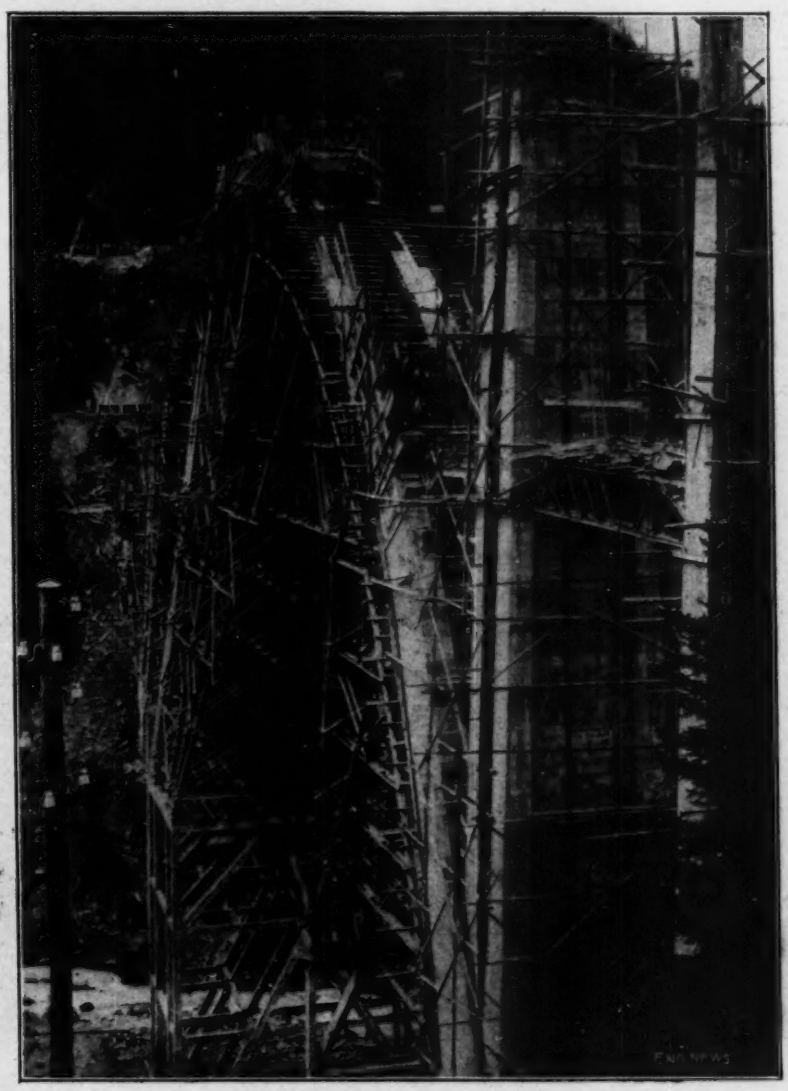

Fig. 1. Centering in Place under the Langwies Arch, Chur-Arosa Ry., Switzerland

The lower portion of the Schanfigg Valley is a wild ravine, and in the upper portion its right slope is furrowed by many deep gorges as far as Langwies, but thence to Arosa fewer constructional difficulties were met. Although the River Plessur is only crossed once—at Langwies—yet there are between Chur and Arosa 27 bridges of stone, three of iron, and two of concrete, as well as 19 tunnels with a total length of 7800 ft.

In the construction of the tunnels, the geological anticipations proved to be correct in every instance, with the exception of the 960-ft. Arosa tunnel, in which clayey moraine-stone and weathered serpentine were met with instead of the gneiss rock which was expected. These much-dreaded moraine formations proved in the wet summer of 1913 to be quite serviceable working ground on which safer foundations were obtainable than, for example, could be got on the detritus declivity below the village of Maladers.

The view on this page shows the famous Langwies Viaduct under construction. As described in Engineering News, Mar. 19, 1914, p. 608, the main arch of this bridge (the second longest masonry arch in the world) has a clear span of 315 ft., and a rise of 140 ft. The viaduct itself is 960

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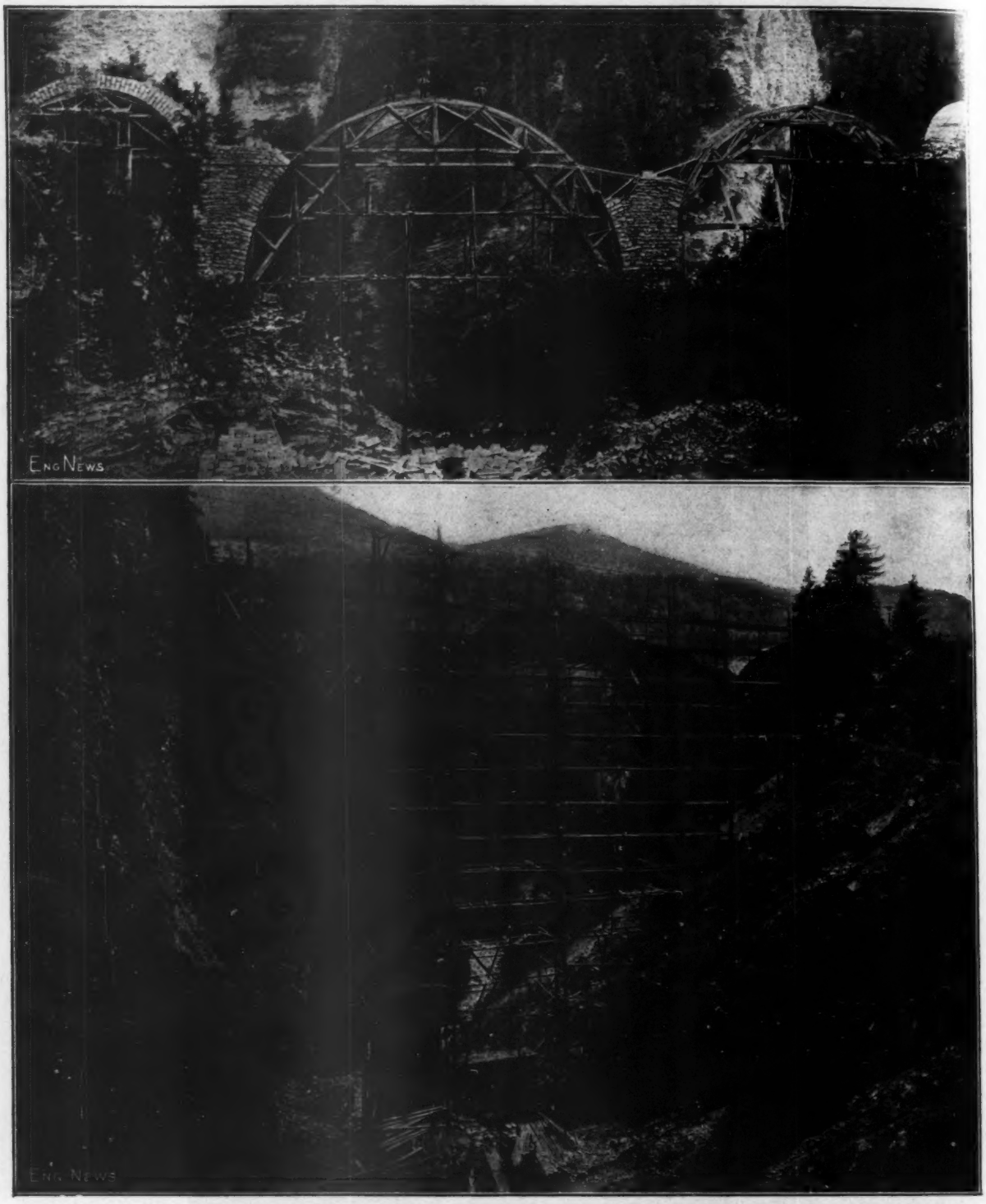

FIG. 2. THE CALFRIES VIADUCT UNDER CONSTRUCTION, CHUR-AROSA RY., SWITZERLAND
FIG. 3. BUILDING THE CASTIEL VIADUCT, CHUR-AROSA RY., SWITZERLAND

ft. long and has a grade elevation of 207 ft. above the valley. The view gives an idea of the very careful construction of the centering for the principal arch, which, after laying the crown concrete, scarcely showed 0.4 in. shrinkage.

Another imposing engineering construction on the line is the Calfreis Viaduct, the centering and piers for which are shown in Fig. 2. Here the two central arches, which have respectively a span of 83 ft. and 60 ft., are built of concrete blocks, while the four lateral arches (40 and

20 ft.) are of tamped concrete. The piers of the principal arch rest on rock, and on account of the scarcity of building stone have a core of tamped concrete cased with quarry stone. In Fig. 3 is illustrated the most imposing stone bridge of the line; it has three arches of 84-ft. span each. The main pier of this Castiel Viaduct has a height of 180 ft. and starts in the middle of the valley.

Superiority of the V-Shaped Flume in Logging*

Of the two types of logging flumes in general use in the United States, the V-shaped has proved more satisfactory, both from cost to construct and efficiency of operation. The square or rectangular flume is the older, and is still used extensively where economy of water is a secondary consideration. Furthermore, owing to its construction, there is a greater chance for leakage in the square type.

It stands to reason that the flume requiring the least amount of material for construction, the least amount of repairs, and in which logs are least liable to jam, is the best flume for general use. Up to the present time, this description fits the V-shaped flume; but it is not unlikely that the portable metal flume already in use on hydroelectric and irrigation projects will eventually supersede the timber flume.

Design and Construction of the V-Shaped Flume

Degree of Angle—Angles of from 70 to 110° have been tried; but the consensus of opinion favors 90°. Future data and references in this article relate to straight right-angle flumes.

Flume or "Boxes"—Construction methods are dependent upon the kind of material to be handled. The sections of the flume or the "boxes" vary in length from 6 to 20 ft. Sometimes only one thickness of board is used, but more often two thicknesses are employed, with joints broken or staggered. The details of the box construction is largely a matter of individual opinion. The aim almost always is to keep down leakage.

A triangular section of wood sawed to fit snugly into the bottom of the V on the inside is sometimes employed for purposes of reducing the amount of water necessary and strengthening the flume itself. The value of this measure is, however, disputed on the ground of too great cost.

Size of Flume—Material to be handled is a prime factor in determining size. For railway crossties, cants, poles, cordwood, etc., a 30-in. (inside width of one side on slant) flume is usually satisfactory wherever there is sufficient water to fill the flume two-thirds full. For the handling of long timbers or "brailed" (clamped) sawed lumber, the size of the V should be from 40 to 60 in., according to the volume of water available and the size of the material to be handled.

Grade—The grade of a flume is a matter to be carefully considered from the standpoint of subsequent operation. An abrupt descent results in rapid wear of the lining, with consequent increase in the maintenance cost and a tendency toward jamming. In the other direction, 1% is held to be the smallest grade for successful operation; 2 to 5% is better. Flumes have been operated for short distances on a 30% grade, but this is undesirable. The most satisfactory is 2 to 10%, and wherever possible below 15%.

Maintaining a steady or even grade necessitates the use of more or less trestling. In order to know just what length of timber should be cut for the bents, it is necessary that a careful survey should have been made. This matter of a careful survey is of importance in more ways than one.

Curves—For obvious reasons a sharp curve is inadvisable. It throws the weight of the material and water to the outside of the curve, with a tendency toward jamming. The degree of curvature should be kept as low as practicable and should rarely be permitted to exceed 20°. Shorter "boxes" and the closer spacing of supporting bents are very necessary in sharp curves.

Cost of Construction—The cost of constructing flumes is, of course, a variable. Rough lumber suitable for construction can ordinarily be cut and fitted at from $7.50 to $10 per M. The cost of construction of the Bear Cañon flume in Montana, a 26-in. V, 10 mi. long, was approximately $2000 per mi. Lumber cost $8.50 per M. to manufacture and fit and about 100,00 ft. b.m. were required per mile. Labor cost $800 per mi., and $350 per mi. was expended for surveying, nails, steel, etc. This flume, however, was constructed a number of years ago, when the cost of material and labor was less than at the present time.

Probably one of the best examples of modern V-shaped log-flume construction is a flume recently constructed on Rochat Creek, near St. Joe, Idaho. This flume, which is unusually large, and strongly constructed for handling large, heavy logs and long timbers, is said to have cost approximately $8000 per mi. for the 5 mi. of its length. This figure includes the cost of constructing a wagon road and of a telephone-line equipment, which latter is a valuable adjunct to flume operation.

*From Bulletin No. 87 of the United States Department of Agriculture; "Flumes and Fluming," by Eugene S. Bruce, expert lumberman. The article discusses the use of flumes in lumbering operations, and tells how to build them, with much valuable data as to the weight of water in different size flumes, velocity of water for different grades in different size flumes, and the amount of material required for their construction.

The Weathering of Coal in the Pittsburgh coal bed where it outcrops on a hillside near Bruceton, Penn., was carefully investigated by the U. S. Bureau of Mines, and the results published in a recent bulletin. The data are applicable as a basis for approximate estimates of the alteration of the same bed in other mines similarly situated. It was demonstrated that indications of weathering such as yellowish coatings of iron hydrate or a dull appearance of the surfaces, do not always signify a material change of the chemical composition or heating value of the coal itself. Chemical analyses show that changes in composition have occurred in the coal for a distance of 50 ft. from the outcrop, and that the composition and the heating value of the unweathered coal, computed on the moisture and ash free basis, are fairly constant. An extensive collection of analyses shows that there has been a considerable alteration of the coal substance in the first 40 ft. from the outcrop, decreasing inward. Between 40 and 75 ft., the alteration was slight, and beyond 75 ft. was not perceptible. The alteration manifests itself in a decrease of calorific value (16.3% at 5 ft., 6.6% at 20 ft.), and an increase of oxygen (amounting to 10% at 5 ft.), with a corresponding decrease of carbon and hydrogen. Beyond the zone of weathering (75 ft.), the variation in the largely adventitious constituents, moisture and ash, is not to be regarded as having a relation to the outcrop. The percentage of sulphur in the weathered part of the bed is less than half that of the fresh coal.

Because of the prevailing prejudice against coal having a rusty appearance, and the popular belief that its evaporative power is less than that of fresh looking coal from the same mine, a series of evaporative tests were run on two samples. The results were practically identical.

Building a Granite Shaft 300 Ft. High: The Perry Memorial

An interesting piece of high-class masonry construction is being carried out by contractors J. C. Robinson & Son at Put-in-Bay, Ohio. They are building there the Perry Memorial, a granite monument in the form of a Doric column 300 ft. high, which is to commemorate Commodore Perry's naval victory on Lake Erie in the War of 1812. Work was begun late in 1912, and will be completed this fall. At present the structure has progressed to a height of about 225 ft.

The shaft of the great column is 45 ft. in diameter at the base and 35½ ft. at the throat, just under a square cap 47½ ft. on a side. Its height from top of concrete base to top of cap is 300 ft., but an attic 17 ft. high and a huge bronze lantern 18 ft. high make the total height 335 ft. above base, or about 360 ft. above bottom of foundation. The taper of the shaft is not straight but has the classical entasis, the curve of the side swelling about 4 in. out from the chord. The Doric fluting is a striking feature of the shaft; there are twenty flutes,

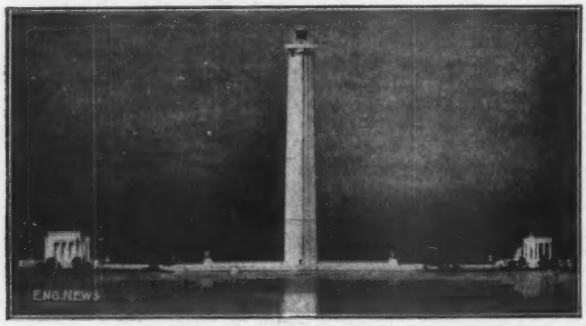

FIG. 1. DESIGN FOR PERRY MEMORIAL MONUMENT
(From the architect's preliminary drawing.)

meeting in sharp arrises, from base to echinus just below the cap.

The exterior of the shaft is of Milford (Mass.) granite, backed with concrete to a circular well 27½ ft. in diameter extending the full height of the monument above a ground-floor rotunda. The wall thickness of the shaft thus ranges from a trifle less than 9 ft. to 4 ft., including the granite exterior (8 in. to 30 in.) and a 4-in. brick lining of the well. The lower story is a rotunda, about 20 ft. high, and a trifle less in diameter than the well above; it is roofed with a flat elliptical dome of Bedford (Ind.) limestone backed with concrete. The interior of the rotunda is faced with limestone in decorative panels. Two spiral stairways are formed in the wall around the rotunda, leading to a reinforced-concrete floor a few feet above the domed ceiling.

From this floor, a central elevator hoistway 7 ft. square, and a reinforced-concrete staircase surrounding it, extend to the top of the monument. The reinforced-concrete flights are supported by four continuous concrete columns set in a square of about 13 ft., and resting on reinforced-concrete girders between floor and dome. The columns are octagonal, 16 in. on a side, reinforced with eight ⅝-in. longitudinal rods. There are no floors above the foot of the elevator, the well being open all the way to the top.

An interesting structural feature is the square cap of the shaft which is a reinforced-concrete slab resting on top of the circular shaft. This cap slab has deep reinforced-concrete girders around its outer edge, which form the parapet of a walk way around the attic. The granite facing of the shaft continues along the under side of the cap and the outside of the parapet; the stones here are cut with heavy longitudinal dovetailed keys projecting from their back faces, which will bond into the concrete and so carry the stones. It will be necessary to set this stonework complete (on falsework) before casting the reinforced-concrete slab and girders. The overhang of the cap being about 10 ft. on the diagonals of the square, and the stones of the underside being radial, without transverse joints, large weights will have to be handled and substantial falsework provided for suspending the stonework until the concrete is in and has taken its set.

THE FOUNDATION

The monument is located on a narrow neck of land about midlength of Put-in-Bay Island, where the distance from water to water is less than 500 ft. This neck was a marsh, with rock 10 to 15 ft. below water. Fig. 2 suggests the nature of the site. Both the monument itself and the extensive concrete esplanade which later is to be built around it must be carried to rock foundation.

The monument foundation is ring-shaped. It was constructed between walls of sheet piling driven to rock—except when boulders stopped the sheeting, as the subsequent excavation disclosed. Inflow of water and soft ground, and the necessary removal of boulders, caused much trouble and delay, and the continuous high level of the lake in the spring of 1913 did not improve matters. When rock was finally reached and cleaned off and a little stepping done, the concrete placing was a simple matter, and the ring was soon built up to grade, about 10 ft. above ground. Toward the end of June, 1913, the base was ready for the shaft to be begun. Setting the first ring of stone was hurried, and the formal corner-stone-laying occurred on July 4. Fig. 2 shows the condition of the work a few days earlier.

BUILDING THE SHAFT

The granite facing is laid out in 3½-ft. courses (3 ft. 9 in. near the base). It is set two courses at a time, and the concrete backing for these is then placed before more stone is set. Flat anchor-straps hooked into holes in the beds of the stones tie them back into the concrete, though the grip of the concrete also binds them in efficiently.

Setting the stone is the main operation. The courses of stone are all different (on account of the batter) but have the same bond, as sketched in Fig. 8. By shifting the ring shown in Fig. 8 one flute either way, the bond of the next course is represented, but the next course is deeper, header and stretcher courses alternating. There are only three patterns of block per course, making up a width equal to two flutes, so that there are 30 stones per course. The cutting is all done at the quarry. Joints are cut true for a width of at least 4 in., back of which they recede.

In setting the stone, the sharp arrises between flutes must be plumbed perfectly, and the batter must be set true. For the latter, a cleat or block of proper thickness, nailed to the edge of the plumb-level near one end, enables the batter to be obtained by direct plumbing. The

clear must be changed at each change of batter (usually every three courses).

Each stone is set with its face true to the stone below at the bed joint, and every two courses the diameter is checked up. Any variation from correct dimensions is noted, and made up in setting the next course.

As a stone is hoisted to place it is lowered onto its mortar bed by the derrick, set true and plumb, while the derrick still holds the strain, and then wedged in position by wooden wedges. After slacking off the derrick, mortar is packed into the back of the bed joint to fill, while the builds are just closed with mortar, leaving the further filling for the concrete.

The back of each stone is painted with R. I. W. to prevent staining. The granite (also of limestone facing in the rotunda) is laid in mortar of white Medusa portland, made near-by in Sandusky. The face joints will be pointed with the same mortar after completion of the masonry.

Concreting back of the facing is done against segmental inner forms. A central concrete hoist dumps its bucket automatically into a hopper bracketed to one side of the hoist tower near its top (several feet above the highest level of wall to be built with that setting of the tower), and from here the concrete is distributed to the wall forms by chutes. The forms are strutted to the tower

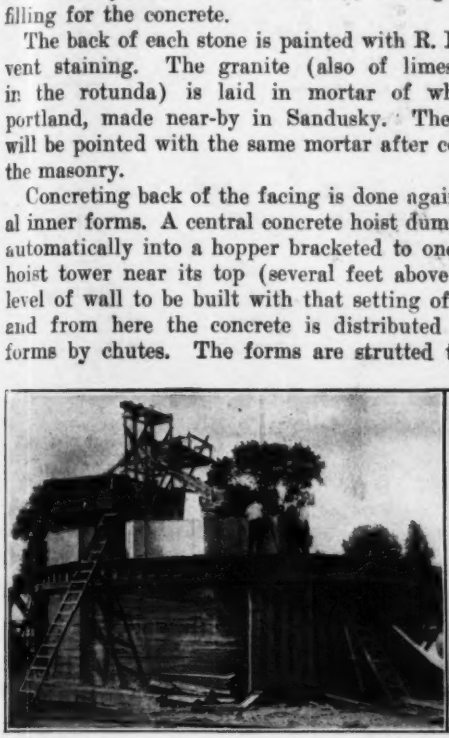

Fig. 2. Setting Stones for First Ring, June, 1913

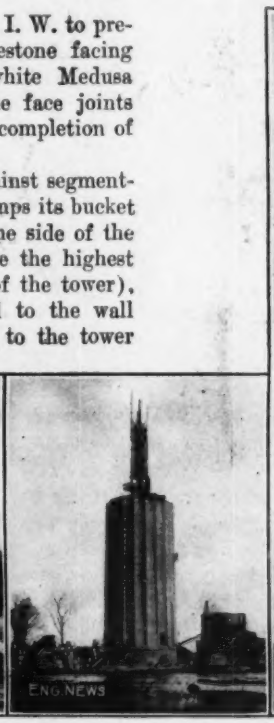

Fig. 3. Tower 90 Ft. in Height, January, 1914

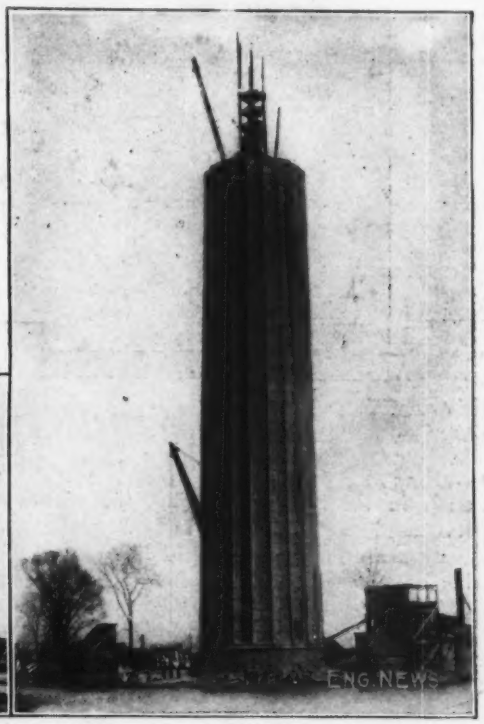

Fig. 4. Tower 185 Ft. High, April, 1914

Figs. 2-4. Three Stages of Progress on the Perry Memorial

(sometimes clear across to the opposite wall), and the bond straps of the granite stones are wired inward to the forms.

In a few cases, the pressure of the liquid concrete placed behind the granite pushed out a facing stone. These accidents prove that thorough tying is important.

The concreting is done in heights of but two courses for the reason that the third or header course would create a difficult pocket to fill solid. However, the matter of pressure of concrete would probably also be troublesome at depths greater than two courses or 7 ft.

Handling Material

The lower part of the shaft was set by a yard derrick close by. This is a derrick with 65-ft. wooden mast and 90-ft. steel three-section extension boom, which normally handles the stone in storage around the base of the shaft and serves the concrete mixer plant alongside. Above the reach of this derrick, all work was done from the inside.

The weights of single blocks in the lower section ran up to as much as 5 tons; generally in the shaft the weights were around 2 to 2½ tons, but in the cap some 4- to 4½-ton blocks will have to be handled.

Two stone-setting derricks are stepped at diagonally opposite corners of a timber tower which is built up in the center of the well, around the permanent elevator framing, and this framing is used as the equivalent of derrick masts. Within the elevator frame a self-dumping concrete hoist operates, to a height which may be as much as 70 ft. above the wall when extended for a fresh raise. Only the concrete is taken up in this hoist; stone is hoisted outside by the two stone-setting derricks.

The construction of the derrick tower is sketched in Fig. 9. The steps for the booms are bracketed just above a square ring of 4x14 timbers clamped around the elevator angles. This ring is carried by eight 12x12-in. raking struts set on jack-screws in notches cored in the concrete about 30 ft. below the boom steps. The struts are in the planes of the sides of the elevator frame.

The topping-lift block is hitched to a forged ring fastened to the corner of the elevator frame about 25 ft. above the boom step. Back of this ring are attached two 1-in. wire-rope guys extending about 60 ft. down to an anchorage in the concrete wall of the shaft. There are two guys at each corner of the tower, eight in all; the guys on each face of the tower are crossed, as shown in the sketch, so that in ground plan they are in planes nearly parallel to the diagonals of the tower. The mast stress of the derrick goes down the single 6x6x½-in. elevator angle. Timber strutting and bracing are clamped to the sides of the elevator frame above the boom seat to stiffen the mast angles and form a full-braced tower up to the level of the concrete hoist sheaves. Below the boom seats no bracing is used. There are no permanent diag-

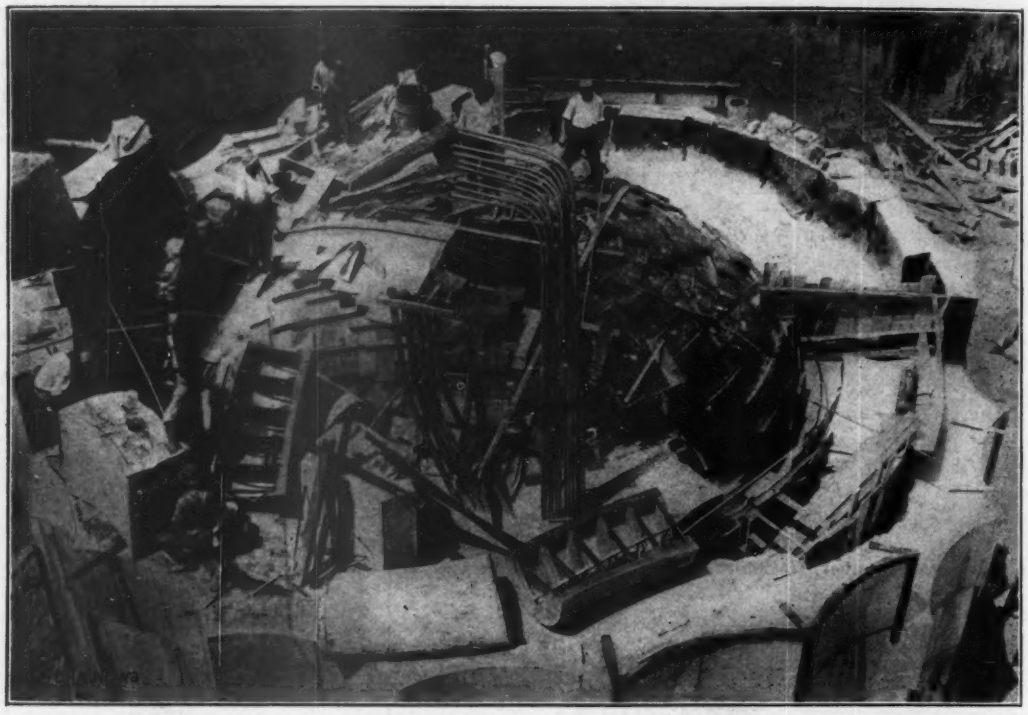

FIG. 5. ELLIPTICAL VAULTED DOME OF ROTUNDA IN LOWER STORY OF TOWER. VIEW OF STONE VAULTING BEFORE CONCRETING

onals in the elevator framing, the reinforced-concrete staircase being relied upon to hold it laterally.

In making a new setting of the derricks, the legs for the boom seats are set on top of the finished concrete wall, notches having been cored out here. Anchor stirrups of 1-in. square iron, concreted in two courses (7 ft.) lower down, give points of attachment for the mast guys which run up to the tower. This allows of setting and rigging the two booms complete. As the concrete hoist inside the elevator framing goes above the level of the mast-top, no horizontal diagonals can be put in to secure the square framing against distortion in a diagonal direction.

The load and boom lines are run down the boom to sheaves at the step, and continue down alongside the elevator angles to the floor above the rotunda. Here they

FIG. 6. CONSTRUCTION OF SPIRAL STAIRWAY

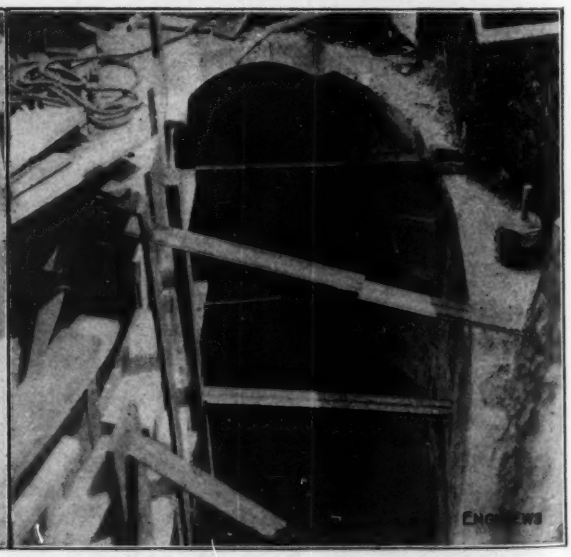

FIG. 7. SPIRAL STAIRWAY AFTER REMOVAL OF FORMS
(Concrete has been roughened for bond with glazed tile lining.)

are turned by two sheaves to pass down just inside the hoistway to the ground, and run out through holes in the foundation wall to the engine house.

One setting of the derricks is counted on for a raise of about 60 ft. of shaft wall. Fig. 9 sketches the extreme positions. With so great a raise, the upper courses of stone interfere with the boom in position for hoisting from the ground, and a gap must be left here, the remaining stones hoisted and set around temporarily inside, and then the gap closed with the boom topped in.

The concrete bins and mixer, alongside the shaft, are supplied by the yard derrick. Concrete is discharged by a chute into the basement of the shaft, whence it goes up by the concrete hoist.

Special Work in the Rotunda

The rotunda involved special work, on account of the limestone side facing, the two spiral stairways in the wall, the dome, and four deep reinforced-concrete girders over the dome which carry the staircase columns above.

The views Fig. 2 and 5 represent the wall construction of the rotunda and the dome work respectively. The

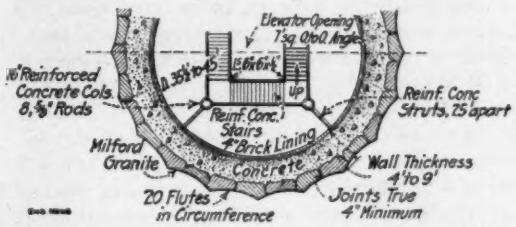

Fig. 8. Sketch of Part Cross-Section of Shaft of Perry Memorial

walls were concreted (in several stages) after setting both granite and limestone and building the forms for the spiral stairways between. The thin stonework of the dome was laid on centering and keyed up, and then backed with concrete; the view indicates the header and stretcher arrangement of the blocks.

Work Inside the Shaft

The brick lining of the shaft, kept far below the wall work, is laid from a ringshaped safety scaffold hung from cross-timbers above. A little lime is mixed with the portland cement in the mortar for the brickwork. Wire loops formed into the concrete wall hold the lining. The brick is buff Kittanning face-brick, practically vitrified, and highly nonabsorptive.

The stairs and their supporting columns are built in stages of about 25 ft., the height of a full turn of four flights. The column reinforcement and the electric-wire conduit inside of it being set, the form is placed and plumbed, and the column then cast to the bottom of the next stair-landing. The depth of column joined to the landing is later cast with the landing, and at the same time a radial strut is cast which here extends from the column out to the wall, bonding into a recess molded in the wall concrete.

The stairs comprise reinforced-concrete stringers on either side, reinforced with rods, and continuous tread and riser construction reinforced with expanded metal. The latter is received in widths just equal to the stair width, and already bent to the required stepped shape in the shop. The sheets drop into place and merely need a few blocks to hold them off the bottom form. Several flights are usually cast at once.

The only standing staging used in the shaft is that required for the column and stairwork. Ladders on side platforms resting on beams thrown across the shaft have

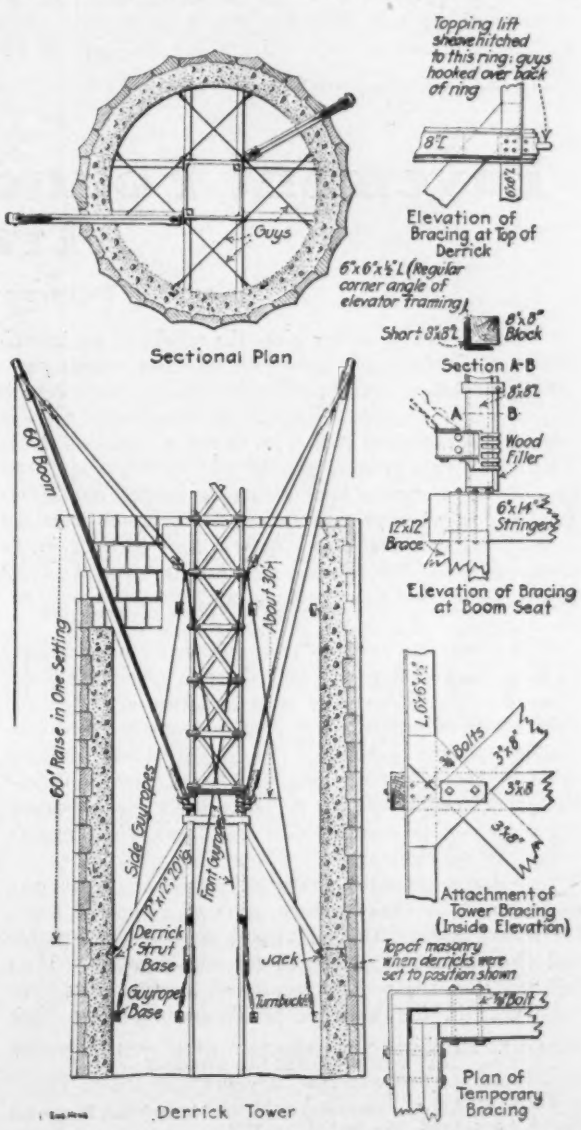

Fig. 9. Erecting Derrick for Perry Memorial

been used for the men up to now, but a temporary passenger hoist is now being installed.

Finish

On completion of the structure, the exterior will have to be cleaned off and pointed up; the sandblast may be used for cleaning. The inside brickwork will also require cleaning of cement stains, etc. The concrete column and stairwork is being rubbed with carborundum brick, holes and voids being first filled with cement.

Reinforced-Concrete Esplanade

The monument itself is to be surrounded by a concrete plaza or esplanade extending from water to water (460

ft.) and about 760 ft. long, in cross shape, covering an area of close to 5 acres. As it is some 10 ft. above present ground level, it is designed as slab-and-beam construction of reinforced concrete resting on piers and walls carried down to rock. The money required for this work is not yet at hand, and the monument will probably stand without the esplanade for a time. The floor of the esplanade will be 4 in. above the base of the granite.

The Perry Memorial Association is building the monument, with subscriptions collected for the purpose; Geo. C. Worthington, Cleveland, Ohio, is President General. Freedlander & Seymour, of New York City, are the architects, and Major Cassius M. Gillette was Consulting Engineer in the earlier stages of the enterprise. Boller, Hodge & Baird designed the structural parts. C. E. Soller is Engineer of Construction supervising the work. The contract work is in personal charge of R. H. Robins[illegible]

Pavement Foundations for Heavy Traffic

By Daniel B. Goodsell*

SYNOPSIS—The author gives the results of an investigation of English experience with portland cement pavement foundations under particularly heavy traffic; especially of motor vehicles. English engineers seem to have come to a conclusion that 6 in. is not a sufficient thickness of concrete to meet present and forthcoming traffic conditions. Concrete foundations for asphalt and wood-block pavements may soon have to be increased from the now almost universal 6-in. depth to 9 or even 12 in. to safely care for the enormous loads put upon them by heavy motor trucks and omnibuses.

The writer has recently had occasion to make inquiry as to whether damage has been done to concrete foundations of city pavements by motor vehicles, and if so the nature and extent of such damage, together with the weight of traffic causing it. The intention was to determine if the present concrete foundations were sufficient and to determine whether occasion exists for increasing the thickness to accommodate the rapidly increasing weight of vehicles.

In order to present an idea of the stresses which may be produced by heavy vehicle units or groups of units, the accompanying Table I, based on observed weights and tire widths, is presented for consideration. It is believed that the weights represent average conditions for trucks in the Borough of Manhattan, New York City. The maximum weights on the axles or tires are not given, and, of course, would be considerably above the average weights shown, which are, in the absence of data, assumed to be evenly distributed on the four wheels.

TABLE I. SHOWING WEIGHTS PER INCH RUN ON TIRES OF FOUR-WHEELED TRUCKS

Power	No. of vehicles averaged	Average tire width per truck in inches	Average load in lb. per tire	Maximum lb.	Minimum lb.
1 horse	19	10.12	572	1263	300
2 horse	68	12.92	843	1333	429
3 horse	10	15.70	1115	1590	850
Auto	9	19.40	822	1154	643
			*(1182)		

*Rear.

TABLE II. SHOWING WEIGHTS OF SOME HEAVY TRUCKS AND LOADS

Power	Load lb.	Width of tires in inches front	rear	total	Lb. per inch run	Weight of truck in lb.
3 horse	16,000	4	4	16	1,000	6,300
3 horse	20,000	4	4	16	1,250	7,000
*20 horse	166,000	14	14	56	2,964	24,000
Auto	6,000	4	8	24	250	8,000
3 horse	35,000	6	6	24	1,458	8,300

*The 20-horse reach truck is believed to be the heaviest in New York City. It is known as the "whale." Its designed load of 100 tons is evenly distributed to the four solid cast-steel wheels with 14-in. faces. The heaviest load so far carried was a steel girder weighing 83 tons, which was used in the Woolworth building. With a load of 100 tons, the weight per inch run of tire is 3571 lb.

*344 W. 72d St., New York City.

A coal firm in the borough, in its busy season, has 450 trucks at work, 9 of which weighing 6 tons each carry loads of 10 tons, 11 weighing 3½ tons each carry 6 tons and 50 weighing 2½ tons each carry 7 tons. Loads of from 10 to 15 tons are common.

A search was made of the proceedings of various engineering societies, of periodicals, etc., for expressions of opinion or statement of facts concerning the subject. What was found is here presented. London is apparently the only city where the damage alluded to has occurred, and, although communication was had with a number of officials in the larger cities in the United States, no information was elicited; and it is hoped that some facts may be brought out by this paper.

Extracts from Printed Reports and Papers

DAMAGE TO ROADS, MIDDLESEX, ENGLAND—As to 6 in. of concrete being insufficient on roads, experience bore out that opinion. On the Green-lanes, Wood Green, after six months' motor traffic the wood paving was found becoming not only corrugated, but in blisters and depressions, and it was necessary to reconstruct the road.

When the wood blocks were removed it was found that the 6-in. concrete foundation underneath was so absolutely fractured that there was not a square yard of sound concrete left. The whole of the material was fractured and damaged to such an extent that it not only had to be excavated, but relaid 10 in. in thickness for the wood blocks, which already showed signs of breaking. Cement grouting is never used in connection with wood paving here, a bituminous filler having been found more satisfactory.—H. T. Wakelem, County Engineer of Midlesex in the "Surveyor," Aug 8, 1913.

EXPERIENCE IN SHEFFIELD, ENGLAND—So far a foundation of cement concrete 6 in. thick, in the proportion of 6 or 8 to 1 (supplemented in the case of wood paving by a "floating" composed of 2 or 3 of sand to 1 of cement) has proved of sufficient strength for the exceptional loads of Sheffield. Such a foundation, used for granite paving, has successfully carried loads up to 40, 50, 80, and occasionally, 100 tons on four wheels. Careful rolling of subsurface was resorted to, and clean broken stone was used for the concrete.—W. J. Hadfield, City Surveyor, in a paper before the Institution of Municipal and County Engineers.

DISCUSSION—With regard to the depth of foundations, experience at Hampstead with motor-bus traffic proved that about 6 in. of concrete was inadequate. The same appeared to be true all over London. No 9-in. foundations are being put in.—O. E. Winter, Hampstead.

The Metropolitan Committee on the Materials and Means of Paving the Streets of London received a number of replies in response to an inquiry whether motor

traffic has had the effect of increasing the cost of paving and maintenance. In most cases the answer is in the affirmative. Many surveyors report that they are finding it necessary to increase the depth of the concrete foundations. In Bermondsey, for instance, while concrete 6 in. deep was formerly sufficient, the depth is now being made 9 in. or even 12 in. In Hackney foundations which were sufficient a few years ago are now found quite inadequate, and in new work the concrete is being made 50% thicker.

The City Surveyor of Hampstead considers that the life of wood paving has undoubtedly been reduced by one or two years, and that it has become necessary to increase the thickness of the concrete foundations from 6 in. to 9 in. In Holborn, concrete foundations 12 in. thick, are being laid in places where a thickness of 6 in. was sufficient ten years ago. In Paddington, concrete from 10 to 13 in. thick is being used on wood-paved carriage ways where the thickness was originally about 7 in. In Westminister the specifications now used when new foundations have to be laid provide for 1 in. of "floating" and 8 in. of concrete foundation instead of 6 in.

FOUNDATIONS OF ASPHALT PAVEMENTS—The thickness of hydraulic concrete necessary will vary under different circumstances. It has usually been 6 in. for sheet-asphalt pavements, carrying the heaviest traffic. At times the thickness is reduced to 4 in. on residence streets. Such a thickness will not be found sufficient to carry the travel which is promised in the future either on such streets or on some of our country highways.

With the advent of the motor truck, the traction engine and the motor omnibus, English engineers have arrived at the conclusion that not less than 9 in. of concrete will be required to furnish a satisfactory support. Such a thickness will be eventually demanded in the United States because in the area included in a radius of 30 miles or more about our own large cities motor trucking is common, with loadings amounting frequently to 10 tons.—"Asphalt Construction," by Clifford Richardson.

EXPERIENCE IN WIMBLETON, ENGLAND—The damaging effect of this latter form of traffic (motor busses), so far as we can see at present, has resulted in the destruction of portland-cement concrete 6 in. thick, where placed beneath wood paving and asphalt.

The author has only found one exception in the London district, viz., that of George St. and High St., Richmond, which carries no fewer than 1155 omnibuses per day of 16 hours, and 1878 on Sundays, equivalent to 55,212 tons per week, on a carriageway 25 ft. in width. The carriageway is paved with 5-in. creosoted deal blocks, laid on a 6-in. portland-cement concrete.

The only reason the author can give for the paving withstanding such a heavy traffic is that it is on a gravel subsoil. In other districts the thickness of the concrete has been increased to 9 in., and where trenches are subsequently made 12 in. is laid as a rule beneath the blocks used in repairing the surface.—Charles Hamlet Cooper, Borough Engineer of Wimbleton, in the "Surveyor," Oct. 10, 1913.

DISCUSSION—In my view, the breaking up of concrete foundations was not caused so much by ordinary motor vehicles as by those over 3½ tons in weight, shod with steel tires, one class of these being allowed to travel at eight miles and the other at five miles an hour. The passage of such vehicles [probably means traction engines with trailers] had the effect of hammering on the road, which did more damage than the twin-tired or any other rubber-tired vehicles (busses or autos)—E. Van Putten, Borough Engineer of Lewisham, London.

REVIEW OF ENGLISH EXPERIENCE—The cost of paved roads was reported to have increased in areas in which the strengthening of foundations had not proceeded very far, but elsewhere this traffic (heavy motor traffic) has not increased the cost of maintenance.

Reports of increased cost of maintenance are usually accompanied by the statement that deeper foundations will be provided in the future. Taking into consideration the increase in the passenger mileage and ton mileage of traffic, the cost of reconstruction and the cost of maintenance, there does not seem to be any cause for alarm as regards the paving of the main routes in the London area.

It is not really necessary, however, to make these foundations of tough concrete throughout, since the greater depth very much reduces the tension on the underside when the foundation acts as a beam or slab, and very greatly increases the area of road bed over which a wheel load is distributed. As a beam a 10-in. slab has 2½ times the strength of a 6-in. slab, and a relatively poor concrete for the lower 4 or 5 in. would in most cases be of ample strength.—Editorial in the "Surveyor," Jan. 30, 1914.

EXPERIENCE IN BELFAST, IRELAND—The concrete bed should be from 6 in. to 9 in. in depth, and vary acording to the subsoil; and having regard to the development of heavy self-propelled traffic, the author is inclined to advise that in no case should the concrete be less than 9 in. deep. —Hector F. Guillan, Superintendent, Works Department, Belfast, in the "Surveyor," July 25, 1913.

CONSENSUS OF ENGLISH RECOMMENDATIONS—The importance of the concrete foundation cannot be over-rated. The foundation should be at least 6 in. in thickness, composed of 1 part of portland cement to 6 of proper aggregate, upon which should be laid a "floating" not less than 1 in. in thickness of 1 part of cement to 2 or 3 of fine granite, slag, or sand, brought up to a perfectly smooth face.—Joint Report of English Engineers, International Road Congress, 1913.

RESULTS OF INQUIRY OF METROPOLITAN PAVING COMMITTEE OF LONDON—Effect of motor traffic on cost of paving and maintaining roads. (Replies by Borough Engineers to queries on above.)

St. Marylebone—The council has increased the depth of concrete foundations for wood paving in the more important thoroughfares from 6 in. to 8 in. and 10 in.

St. Pancras—Many wood-paved streets in this borough have either already been injured or shortly will be by this traffic breaking up concrete foundations insufficient to carry the traffic. The St. Pancras Borough Council have recently had to reconstruct the concrete foundation of Seymour St. when repaving it.

The original concrete foundation was about 6 in. thick, and for many years it proved sufficient to carry the very heavy ordinary traffic of the street, but as soon as two services of motor busses began running, the surface in many places showed indications of subsidence, and on examination the concrete was found to be completely broken up, and it was found necessary at the time of repaving the street to form a new concrete foundation 12 in. thick.

In Great College St. there is a daily and very frequent traffic of a motor steam-wagon, and the condition of the granite pavement in this case indicates the destruction of the foundation.—Tenth Annual Report of Metropolitan Paving Committee, 1911-12.

EXPERIENCE IN THE CITY OF WESTMINSTER, ENGLAND—The City Council last year approved an alteration in their specifications for paving work to provide for the laying of 8 in. of concrete foundation and 1 in. of "floating" instead of 6 in. of concrete, and 1 in. of "floating" formerly specified—this, of course, only to apply in cases where new concrete foundation is laid.

SUMMARY

In review, regarding the sufficiency of the present concrete foundations for heavy automobile traffic, a difference of opinion has developed, some authorities stating that a thickness of 6 in., which is now used, is sufficient; and others, notably Clifford Richardson, expressing the opposite view. The writer has been able to collect very few data about the sufficiency of the present concrete foundations in the United States. There does not seem to be enough experience with the destructive action of heavy trucks to warrant a decisive opinion.

There is a very strong consensus of opinion among the English engineers that both foundation and wearing surfaces should be absolutely stable in character; that both the concrete foundation and the asphalt macadam wearing surface or asphalt wearing surface should be so constructed that the aggregate will not move under traffic. Any movement or displacement of the stones in the surface mixtures by the rolling action of heavy traffic

is said to rapidly lead to disintegration of the surface and foundation.

A comparison of the concrete foundations of London, Liverpool and Paris with those of the Borough of Manhattan is difficult to make by reason of the fact that the mixtures used abroad are more lean than those used in this borough. A 1:2½:6 or even a 1:3:8 mixture is common, particularly in Paris. Gravel concrete is very common in both London and Paris.

An inspection of the concrete foundation of the former pavement of Fifth Ave., Manhattan, which had been down for nearly 15 years, except where removed for openings or other purposes, disclosed the fact that there were many wide cracks and deep depressions due to the subsidence of the soil beneath, which in turn was due to shrinkage of fill; and that the bad condition of the foundation was due almost entirely to such cause, and not to wear.

With such a rapidly growing borough as Manhattan, heavy and dense traffic conditions are likely to continue and no doubt will be such as to warrant an increased thickness of the pavement foundations. If this borough had as thoroughly consolidated subgrade conditions as London, it is doubtful whether there would be need of increase in the thickness of present foundations, in view of the fact that the concrete is much richer, stronger and of a better mixture than that used in either Liverpool, London or Paris.

In the writer's opinion, the concrete foundations for all the different kinds of pavement should be made smooth by "floating" the surface, thereby adding to the strength and accurate contour of the surface, which is desirable for all the different kinds of pavement. This "floating" would require a departure in the treatment of wearing surfaces which would tend to improve them.

Useful New Facts About Materials

NEWS AND RESULTS ABSTRACTED FROM PAPERS READ BEFORE THE AMERICAN SOCIETY FOR TESTING MATERIALS

Permeability of Paints: A New Research Test

Prof. A. M. Muckenfuss (New Orleans, La.) has experimented with a new kind of test for paints, designed to show how rapidly water-vapor can pass through a paint film. It is as follows:

The paint is spread on a support of hardened paper, wire cloth, or cement, and this is laid (with gasket) over a pan of water and under a mercury-sealed cover which incloses a weighed dish of calcium chloride. The weight gained by the calcium chloride in 24 hr. is the measure of permeability.

The results obtained with this test so far are a stimulus to further experiments. By applying the test after exposing the paint film to the atmosphere, the effect of weathering was studied somewhat. Artificial weathering was tried, by subjecting the film to regular alternations of warmth and cold, moisture and drying, electric illumination and darkness, etc.; accelerated "weathering" effects were found to result.

Strength of Glue

O. Linder and E. C. Frost report the results of various tests of ordinary glue. They find that in judging of glues the following qualities should be covered: viscosity of the melted solution, strength of the cold jelly (judged by the fingers), odor, reaction, grease content, liability to foaming, ash, moisture, appearance.

The adhesive strength of 25 samples was tested by gluing a 2x1x1-in. block between two 2x1x½-in. pieces, pressing together under 100 lb. pressure for 12 hr., and, after another 12 hr., pushing the middle block from between the other two on a testing machine. Reducing the results to lb. per sq.in. by dividing by 4, the results showed strengths from 1100 to 1950 lb. per sq.in. for 1 part dry glue to 3 parts water, and 60 to 70% of this for a 1:5 glue.

Prolonged heating lowers the strength. Glue solutions kept heated to 150° F. for 20 hr. showed a loss of 30% to 45% in strength, when tested as above.

New Testing Appliances

A hydraulic compression machine of 125 tons capacity, with width of 10 in. between posts, was designed by W. H. Weston and built for W. O. Lichtner, for testing concrete. It can test an 8-in. square prism to 3900 lb. per sq.in., and an 8-in. cylinder to 5000 lb. per sq.in. Two gages, 10 tons and 125 tons capacity, are attached. The total cost of the machine was $550. Its outside dimensions are 20x32 in. by 60 in. high, and its weight 3000 lb. ("A Simple Compression Machine for Testing Structural Materials," W. O. Lichtner).

Extensometers and compressometers taking measurements on three gage lines, 120° apart, have been used at the University of California. A. C. Alvarez designed them. The measuring is done by roller dials. ("An Improved Type of Axial Strainometer," A. C. Alvarez.)

The American Locomotive Co. has developed a vibratory testing machine claimed to be more accurate and more adaptable than prior machines for vibratory tests. Tension tests, as well as oscillatory tests and rotating vibratory tests under longitudinal tension can be made with full assurance that the grip on the ends will remain firm. A tension up to 40,000 lb. can be applied to the specimen, and a bar of hard steel 1¼ in. in diameter can be tested in the vibratory test. The axis of the machine is horizontal. The machine was built by Tinius Olsen & Co., Philadelphia, to designs of C. L. Heisler. ("A New Vibratory Testing Machine and Results obtained by its Use," S. V. Hunnings.)

A centrifugal sandblast machine for testing brick, etc., by sand abrasion, was built recently at the Municipal Testing Laboratory, St. Louis, Mo., by Mont Schuyler. The vertical shaft of an electric motor, passing up through a fixed horizontal bedplate, carries two oppositely directed tubular horizontal arms. Above these arms the shaft is hollow and at the top it has a feeding funnel. for feeding sand down through the shaft to the arms, whence it is thrown out by the centrifugal force through

the tubular arms. Test specimens may be set on the bedplate in a circle, the tubular arms just clearing the inside of the circle; a sheet-iron cover incloses the working area, the funnel projecting out at the top.

With a given sand, fed in at a given rate, uniform abrasion results are obtained. Different sands give different rates of abrasion, probably due to influence of size of grain. If the machine is standardized in its details and manner of use, it may prove to be a valuable testing device for clay products. In the case of brick, experiments showed a hyperbolic (decreasing) relation between strength and abrasion loss, and a roughly parabolic (increasing) relation between absorption and abrasion, which indicates that the test has practical value. Possibly this form of test may make the rattler test for paving brick unnecessary; it has great advantages in rapidity, definiteness and noiselessness, over the rattler test. ("A Machine for Testing Clay Products," Mont Schuyler.)

Drill-testing to determine the best speed, etc., may be done on a new machine built by Tinius Olsen & Co., Philadelphia. The feed pressure and the cutting torque at various speeds are measured. Drills ¼ to 1 in. diameter can be tested at speeds of 50 to 1000 r.p.m., the low speds taking care of taps and dies. Torque is measured by a pendulum weight as in the Thurston torsion-testing machine. An autographic record of torque is made on a rotating drum. ("An Efficiency Testing Machine for Testing Drills, Taps and Dies," T. Y. Olsen.)

To measure the "friction" of rubber hose or belting, i.e., the resistance of the several plies against unwinding or stripping, J. M. Bierer has made an autographic machine which pulls two grips apart at the standard rate of 1 in. per min., and registers the pull on a steam-indicator cylinder. ("An Autographic Friction Testing Machine for Mechanical Rubber Goods," J. M. Bierer.)

The difficulties and uncertainties of present ways of measuring the viscosity of liquids led Prof. A. E. Flowers to suggest a new type. If a liquid is placed in a tube, the tube inclined a little from the horizontal, and a heavy sphere somewhat smaller than the bore of the tube is allowed to roll down in the tube, the velocity of the ball will depend on the viscosity of the liquid. Thorough review of the subject of viscosity brought Prof. Flowers to the conclusion that an instrument using this principle will be accurate and very adaptable, and subject to only slight corrections for different specific gravities of liquid. A small sample suffices for the test. Tests could be made at high temperatures or under pressure, just as easily as under normal conditions. The ball diameter should be one-half to three-quarters of the bore. ("Viscosity Measurement and a New Viscosimeter," Alan E. Flowers.)

Permanent Magnetism

The amount of permanent magnetism which hard steel will retain, and the tenacity with which it retains it, are profoundly affected by the heat treatment of the steel, as well as by its chemical composition. But different steels are affected differently by heat treatment. Some have their best permanent-magnet quality in the oil-hardened condition, while others (0.60% carbon steel and 5% tungsten steel) are best when water-hardened. Thus, the "magnetic hardness" does not vary in the same way as physical hardness. Drawing the temper, however, reduces both hardness and magnetic permanence. In some steels, pieces of small section have greater permanence than larger pieces, while other steels have the opposite characteristic. These facts are some of the results obtained by J. A. Mathews (Halcomb Steel Co., Syracuse, N. Y.) in a very extensive series of magnetic tests on alloy steels. While these tests are perhaps the most elaborate study ever made of permanent-magnet quality of steels, their chief result up to the present is that no uniformity of behavior is found among different steels, and that no laws or theories covering the phenomena can be deduced before a great amount of further experimenting has been done.

Mathews found the best index of permanent-magnet quality to be the ratio between residual magnetism and coercive force (the reverse magnetizing force required to wipe out the residual magnetism). He proposes this ratio as a new magnetic unit. ("Magnetic Habits of Alloy Steels," J. A. Mathews.)

Hardness Tests of Metals

Tests of various metals for Brinell hardness and scleroscope hardness, made at Watertown Arsenal, have been plotted to show what relation exists between the two kinds of hardness. A straight-line relation was found, but different metals lie on different straight lines (all passing through the origin). Carbon steel, nickel steel and chrome-nickel steel fall on the same line, for which the Brinell number is 6.67 times the Shore scleroscope number. Bronze, cast iron and aluminum have lower ratios of Brinell to Shore number, but the tests do not show clearly what these ratios are; that for cast iron is about 5.3. ("Hardness Tests, Relation between Brinell Ball-test and Scleroscope Readings," J. J. Thomas.)

A Simple Deflection Formula for Reinforced-Concrete Beams

The deflection of a beam may be expressed by the area of its M/EI diagram, and this in turn is, for any given method of support and loading, proportional to the maximum moment. From these facts may be derived the following simple formula for deflection of a reinforced-concrete beam:

$$f = k\frac{l^2}{d}(e_c + e_s)$$

in which

f = deflection;
k = a constant;
l = length of beam;
d = depth of beam, to center of steel;
e_c = unit-deformation in extreme fiber of concrete;
e_s = unit-deformation in extreme fiber of steel.

The constant k, in simply-supported beams, has the following values: For uniform loading, $k = 0.1041$; for center loading, $k = 0.0833$; for third-point loading, $k = 0.1065$. In fixed-end beams the values are: For uniform loading, $k = 0.0313$; for center loading, $k = 0.0416$; for third-point loading, $k = 0.0347$.

The formula has been checked by the results of numerous tests of reinforced-concrete beams. ("Relation be-

tween Deformation and Deflection in Reinforced-Concrete Beams," G. A. Maney).

Fictitious Yield-Point Obtained for Reinforcing Bars by Testing Turned Sections

In testing deformed bars used for concrete reinforcement, it is permissible (according to most specifications) to make the test on a piece turned down to cylindrical shape. At the St. Louis municipal testing laboratory, it has been found that such tests show a higher yield-point than the true one. The error may be as much as 10%. Not only deformed bars, but also plain bars, showed this liability of error. It is due to the nonuniformity of a rolled bar, the interior being of more fibrous structure than the exterior, as photomicrographs revealed. ("The Use of Turned Sections in Tension Tests of Reinforcing Bars," E. P. Withrow and L. C. Niedner.)

Water Purification Plant, Belfast, Maine

By Robert Spurr Weston*

The works of the Belfast Water Co. have recently been improved by building an additional impounding reservoir on Little River and a 1,000,000-gal. water-purification plant consisting of a coagulating basin, two 500,000-gal. mechanical filter units with Wheeler filter bottoms, a filtered-water basin and a wash-water tank. The filter plant was put in service in January, 1914, and is now supplying about 400,000 gal. a day.

Although the object of this article is to describe the purification plant, a few words may be said regarding Belfast itself, the water-works as a whole and the new dam.

The City of Belfast is situated on the westerly shore of Penobscot Bay, between the cities of Bangor and Rockland. It is the seat of Waldo County and is the marketing town for a locality devoted to dairying and fishing. There are also shoe, clothing, leatherboard and woodenware factories, besides a shipyard. During recent years the beauties of the bay and its shores have attracted an increasing number of summer residents.

Dam and Water-Works—The original water-works were designed and built, in 1887, by the firm of Wheeler & Parks, of Boston. They consisted of an impounding reservoir with granite masonry dam and pumps operated by both steam and hydraulic power, discharging through about two miles of 10-in. mains to city and standpipe—against a head of 250 ft.

The dam and pumping station are located on Little River, 1.9 miles south from the center of the town. The storage has been only sufficient to drive pumps by water power for three or four months out of each year. So, during 1913, the storage has been increased by building another dam about three-quarters of a mile up the stream.

This dam was built of concrete masonry. Its crest is 220 ft. long and 30 ft. above the bed of the stream; the spillway is 90 ft. wide. The end portions of the dam are straight with the central or spillway section arched. The dam is 13 ft. thick at the bottom and 4 ft. 3 in. at the flow line of the reservoir. It contains very little reinforcement. It was designed by William Wheeler, Supervising Engineer for the Company, and built by the M. W. Allen Construction Company of Walpole, Mass., under the supervision of G. A. Sampson of the writer's office. It required about 200 cu.yd. of earth and 50 cu. yd. of rock excavation; and contained about 700 cu.yd. of concrete, besides gates, pipes and appurtenances. The total cost, exclusive of engineering, was about $8500.

The water supplied directly from the reservoir to the town, while safe to drink, was objectionable on account of its high color and, at times, its pronounced odor and

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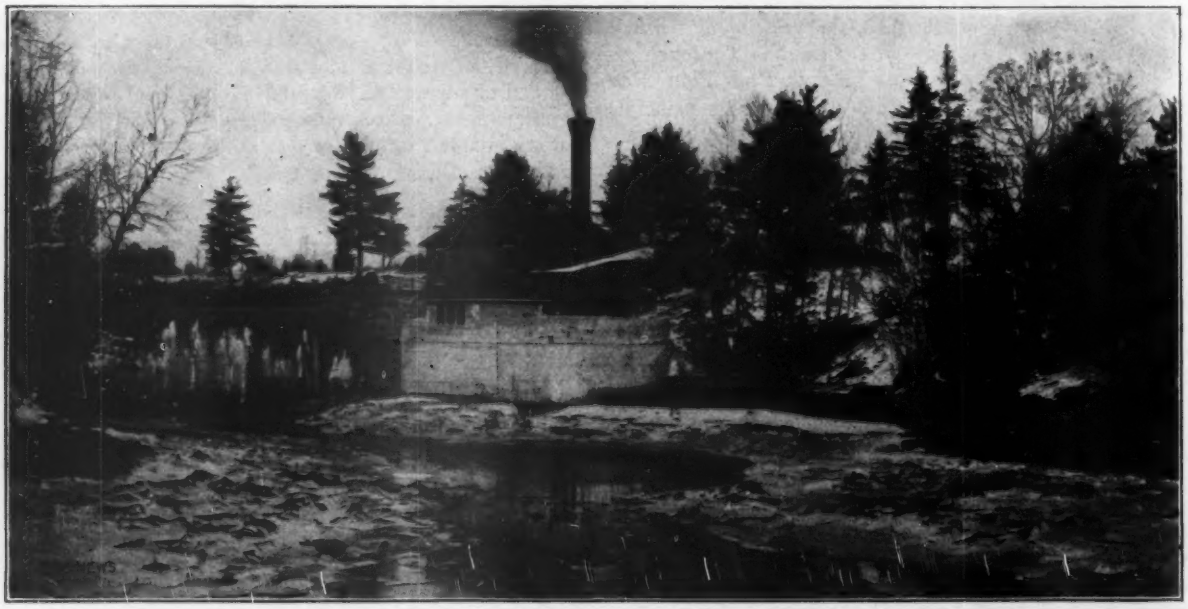


Fig. 1. Dam, Pumping Station and Purification Plant of Belfast Water Co.

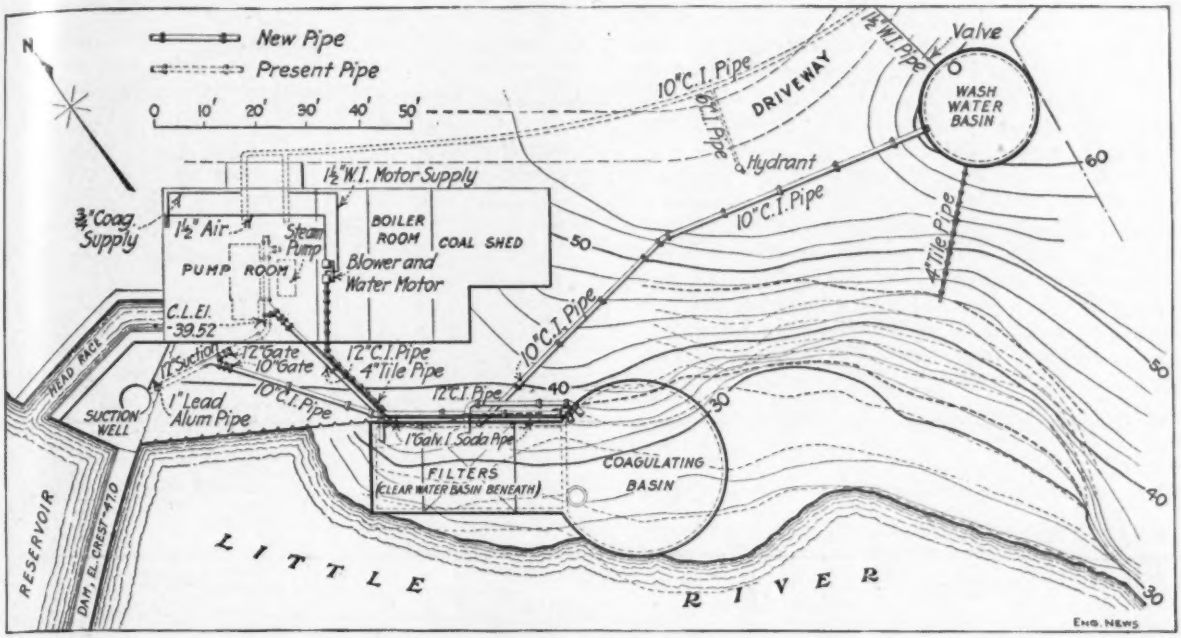


FIG. 2. LAYOUT OF BELFAST WATER-PURIFICATION PLANT

turbidity. The character of the water is illustrated by the following typical results of analysis:

Source of sample	Reservoir
Date of collection	June 17, 1912
Odor, cold—20° C.	1—vegetable
Odor, hot—90° C.	4—vegetable
Turbidity—silica standard	15
Color—platinum standard	70
Oxygen consumed	6.82
Nitrogen as: Free ammonia	0.022
Albuminoid ammonia—total	0.124
Suspended	.....
Dissolved	.....
Nitrites	0.000
Nitrates	0.06
Chlorine	2.16
Alkalinity	10.0
Hardness by soap method	20.8
Iron, Fe.	0.45
Residue on evaporation: total	41
Bacteria per c.c.—20° C.	145
Bacteria per c.c.—37.5° C.	62
Bacillus coli	Negative
B. coli—presumptive test	Negative

WATER-PURIFICATION PLANT

In addition to the increased storage, which will improve the water, the company has built a water-purification plant, of 1,000,000 gal. daily capacity, consisting of coagulating basin, two 500,000-gal. filter units with Wheeler filter bottoms, filtered-water basin and wash-water tank.

The plant was designed by the writer and built by John W. Gulliver of Portland, Me.; it cost $16,000, including engineering and changes in the pumping station. John M. Cashman was Resident Engineer for both dam and water-purification plant.

The water requires treatment with sulphate of alumina, and, at times of low alkalinity, with soda, followed by storage in a coagulating basin for at least two hours and filtration through mechanical filters. At this writing, less than twenty parts of sulphate of alumina and 5 parts of soda per million are required.

The plant is located on the bank of the tidal estuary near the pumping station, as shown by the view, Fig. 1, and the plan, Fig. 2. The filters and adjoining coagulating basin are in the form of a circle intersecting a rectangle. Beneath the filters, and supporting them, is a filtered-water basin. Both pump well and coagulating basin rest directly upon and conform to the sloping rock on the bank of the estuary.

The reservoir water is supplied to the coagulating basin by gravity, through a 10-in. pipe terminating in a float valve within the basin. Sulphate of alumina is added to the water as it leaves the reservoir, and soda either as the water enters or leaves the coagulating basin.

COAGULANT SOLUTION TANKS

The devices for applying coagulant consist of four solution tanks and two feed boxes, all of reinforced concrete, and two porcelain sinks connected with the two feed pipes, all as shown by Fig. 3. The sulphate of alumina tanks are each 3.25 x 5 ft. x 5 ft. deep.; the soda tanks are half as large. In the corner of each tank is a solution box with perforated bottom and removable screen. Each tank is provided with air pipes for stirring the solution, the air being supplied by a No. 00 Sturtevant pressure blower driven by a 6-in. Pelton wheel. The waste from the wheel discharges back into the filtered water basin.

The solutions discharge from the tanks into feed boxes provided with ball cocks and glass or brass plates, with 20 orifices drilled in each plate, similar to the devices used at Steelton, Penn., and elsewhere. All working parts coming in contact with sulphate of alumina were made to resist corrosion. The screens and air pipes are of hard rubber, the piping is of phosphor bronze, the ball and orifice plate are of glass and the tanks themselves have been given three coats of a solution of white Japan-wax in turpentine. Brass and galvanized iron were used in contact with the soda solution.

The solutions fed through the orifices fall into the two porcelain sinks connected with their respective feed pipes.

COAGULATING BASIN—This (Fig. 4) is built of reinforced concrete with a concrete and earth cover. It is

of irregular shape and has a capacity equivalent to two hours' flow. The treated water enters through the float valve near the bottom and flows over a funnel-shaped outlet into the 10-in. influent pipe. The bottom of the coagulating basin slopes to a 10-in. drain; a concrete overflow wier is also provided.

FILTERS AND WHEELER FILTER BOTTOM—The filters (Fig. 5) consist of two 500,000-gal. units, each having an area of 192 sq.ft. The filter sand was obtained from Old Orchard Beach, Maine, and has an effective size of 0.41 mm. and a uniformity coefficient of 1.58. The sand layer is 2.5 ft. deep and rests upon a graded gravel layer, 6 in. thick, supported by the Wheeler filter bottom.

The three gravel layers are of the following sizes and thicknesses:

Layer	Thickness, in.	Size
Top	3.0	No. 4 to No. 12 mesh
Middle	1.5	0.5-in. to No. 4 mesh
Bottom	1.5	0.75-in. to 0.5-in. mesh

These very thin layers of gravel were made possible

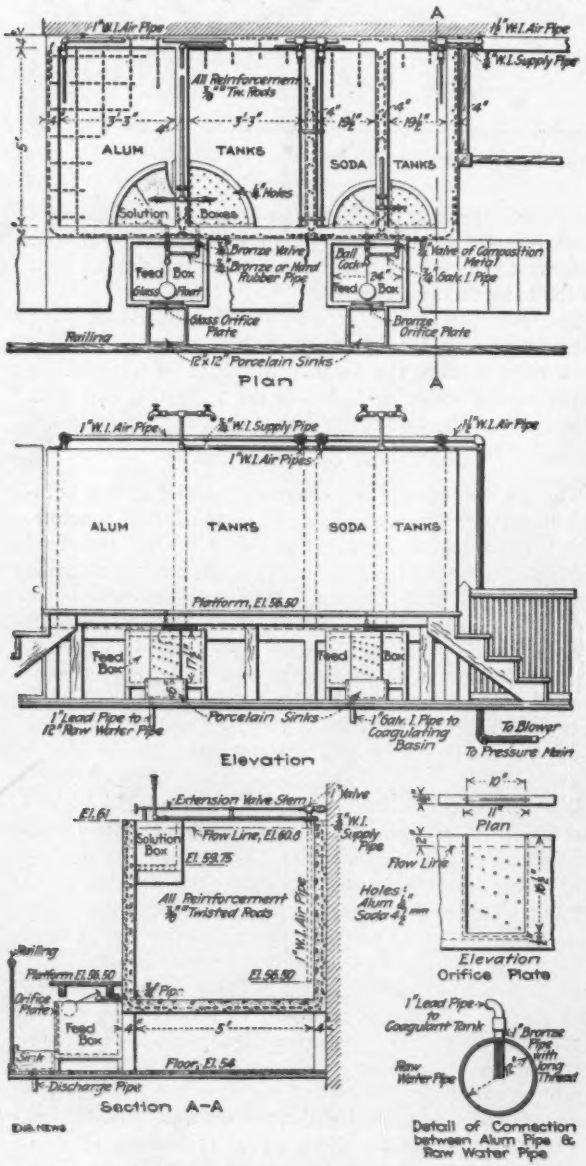


FIG. 3. DETAILS OF COAGULANT SOLUTION TANKS

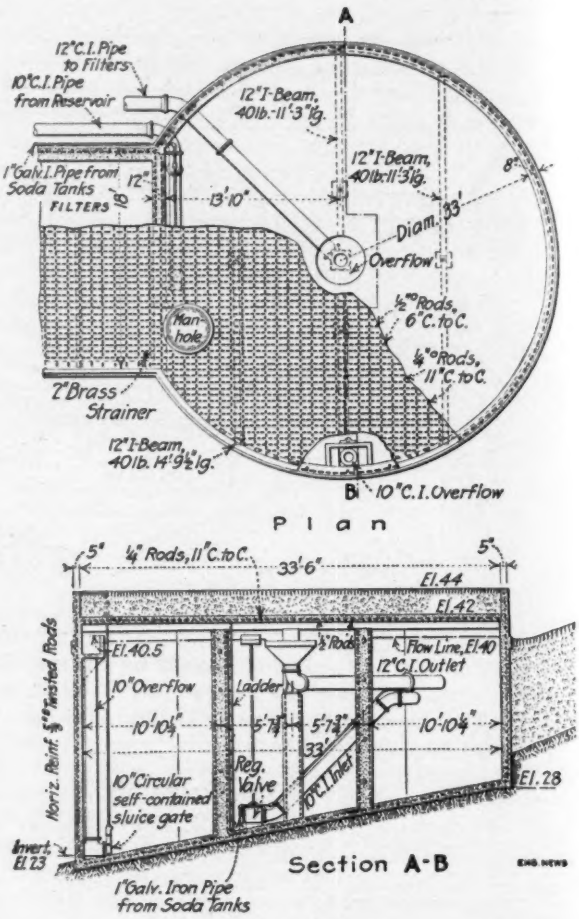


FIG. 4. COAGULATION BASIN, BELFAST FILTERS

ty the Wheeler filter bottom* upon which the gravel rested. This device was invented by William Wheeler† to overcome some of the disadvantages of those filter bottoms which are provided with inverted pyramids or troughs, either filled with a very thick layer of gravel or having the lower layer of gravel held in place by screens.

The Wheeler filter bottom consists of a series of inverted pyramids, spaced 1 ft. c. to c. and containing four 3-in. spheres molded from neat cement. These spheres, arranged according to a definite mathematical principle, take the place of the usual random arrangement of gravel or other supporting and wash-water distributing media.

Above the 3-in. balls and around the sides of each pyramid were placed eight glazed earthenware marbles, each 1.25 in. in diameter, and over the larger central space hand-picked beach pebbles of a diameter of about 1.5 in. The 0.75-in. outlets discharge into channels in the concrete, communicating with the 6-in. effluent pipe.

The filter piping is contained within the pipe gallery between the filters. The effluent pipes discharge into the filtered-water basin through Venturi meters and controllers, the recording devices for which are located on the operating platform above. The effluent valve is provided with a hydraulic piston actuated automatically by

*"Engineering News," July 2, 1914.
†Consulting Engineer, 14 Beacon St., Boston.

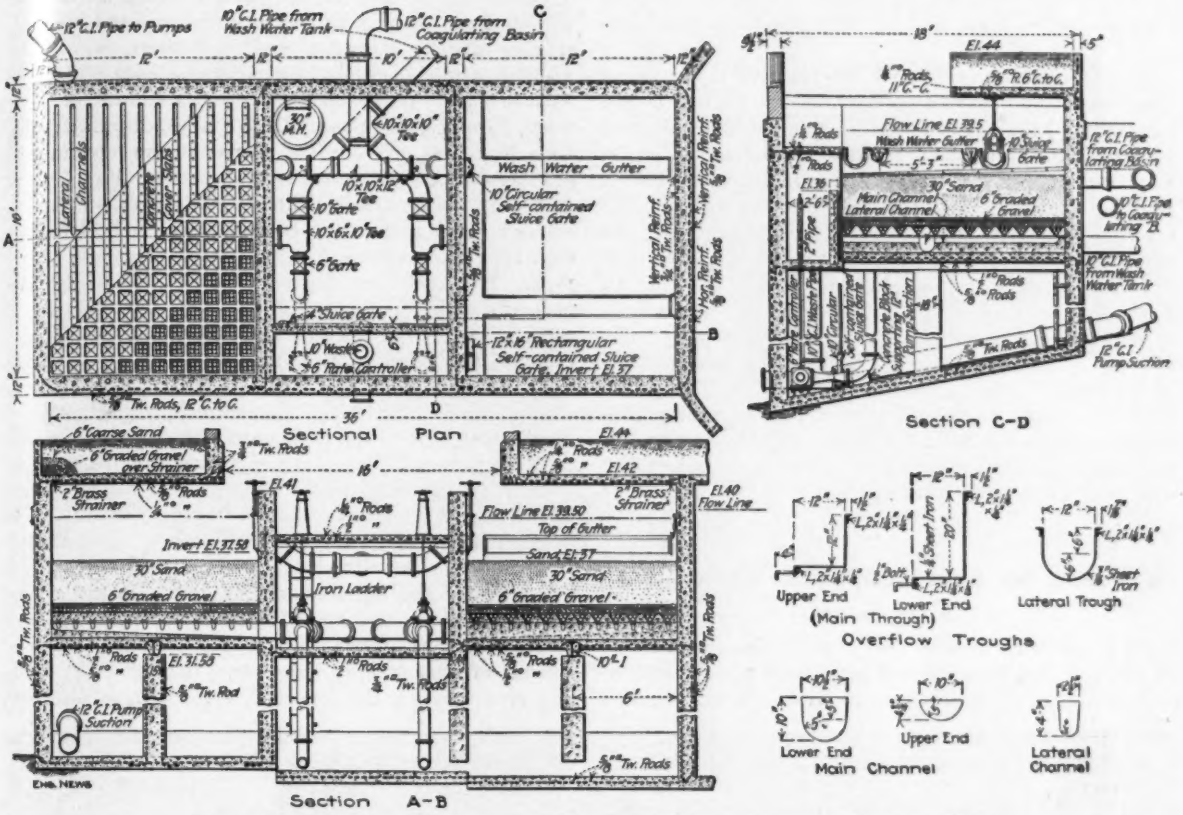


FIG. 5. MECHANICAL FILTERS WITH WHEELER FILTER BOTTOM, BELFAST, ME.

the Venturi devices. The filters are designed to operate without using negative heads.

The wash-water gutters (Fig. 5) are of the usual type. The 8-in. influent gates and the 12x16-in. waste gates communicate with these gutters. The waste gates discharge into a concrete compartment at the end of the pipe gallery. This compartment is connected with a 10-in. waste pipe passing through the pump well, discharging into the estuary; it also serves as an overflow for the filtered-water basin. At the bottom of the filtered-water basin a 10-in. drain connects with the waste pipe.

The 12-in. pump suction connects directly with the filtered-water basin.

The wash-water tank is located on the hill above the filters. It is built of reinforced concrete and is 20 ft. in diameter by 20 ft. deep, with 8-in. walls and a 4-in. cover. The tank is supplied with water from the high-service and a 10-in. wash-water main with 8-in. branches leads to the filters. The tank is provided with a float valve on the inlet and a 4-in. overflow.

Statistics of United States Railways in 1913

The Interstate Commerce Commission has issued an advance abstract of the official statistics of steam railways in the United States for the fiscal year ending June, 1913. This year witnessed by far the greatest volume of passenger and freight traffic that has ever been carried on American railways. The business of the year ending June 30, 1914, has shown a large falling off, as is generally known.

The density of traffic in 1913 is perhaps best shown by the figures for passenger and freight mileage per mile of road. In 1913, 143,067 passengers were carried one mile per mile of road, against 140,393 in 1912. In 1913, 1,245,158 tons of freight were carried one mile per mile of road, as against 1,110,811 tons in the preceding year. A general review of the financial results of operations is of interest, in view of current discussions of the relations of the railways and the public. We omit the details and give the figures in round millions, for the sake of easy comprehension.

In 1913, the railways covered by these statistics (including all roads earning over $100,000 in the year, an aggregate of 244,400 miles of road operated) had total earnings from operation of 3125 million dollars. Of this amount, there was paid out in operating expenses, 2169 million, leaving them 955 million as net earnings. Out of these net earnings the railways had to pay 122 million in taxes, leaving them a net income from operations of 835 million. The railway companies also received from investments in stock of other companies, leased roads, etc., 283 million. They had to pay out in rentals on leased roads, etc., and in interest to holders of bonds and other debts, 630 million, leaving them a net corporate income of 488 million. The money was used first to pay 242 million in dividends to the stockholders who owned this 244,000 miles of railway; $48,000,000 was spent on additions and betterments to the railway property, $50,000,000 on miscellaneous appropriations, and a balance of $184,000,000 was placed to the credit of profit and loss. It will be seen from the above figures that of every dollar which the railways receive in payment for freight and

passenger transportation they paid out 69c. in operating expenses, 4c. in taxes, and 8c. in dividends to stockholders.

The total capitalization of the railways is, in round numbers, 19,800 million dollars. About a third of the outstanding railway stock received no dividends and about 10% of the railway bonds received no interest. The average receipts per passenger per mile in 1913 were 2.08c., and the average receipts per ton-mile were 0.729c. The average passenger train earned $1.35 per mile run; the average freight train, $3.24 per mile run. The average freight train carried 445.25 tons of freight. In 1912, the average was 410.26 tons. Of the total railway earnings, about three dollars came from freight traffic to every dollar from passenger traffic. The total number of employees in the railway service was 1,815,239. The total amount of wages and salaries paid to railway employees was 10,373 million dollars. Thus for every dollar paid out by the railways in operating expenses, 63c. was paid directly to railway employees in salaries or wages.

A Visit to the Lassen Volcano*

By W. H. Wright†

An eruption on Lassen Peak, California, occurring at 10 a.m. Sunday, June 14, had just ceased when I arrived at Prattville, Cal., on the way to Drake's Springs. The dust-cloud still hung over the mountain. A resident of Prattville stated that this had been the largest of all outbreaks and earnestly sought to dissuade me from going on to what he seemed to consider certain death.

I visited the peak with two companions on June 16, under guidance of Harry Kaul, who had spent the winter at Drake's Springs as caretaker. Kaul stated that on Thursday night, May 28, he heard a rumbling like that of thunder. Upon going out of doors he found the stars shining brightly. Also that on Friday afternoon, at 2:30, a slight earthquake caused the poorly fastened roof of the barn to slide to the ground. This shock was felt in Westwood, 29 miles, and Susanville, 51 miles, distant. At this time Kaul was probably the nearest to the mountain of any person in that region. On Saturday, May 30, the first eruption occurred, although a stage driver reports seeing a vapor rising from the mountain on Friday. Two days after the eruption, Kaul accompanied a party to the peak. The crater or fissure was then about half its present size, but general conditions were the same. There was not so much debris scattered about, and a small pool occupied a depression in the old crater. Since that time numerous eruptions have taken place, and have all been of the same character. Tin cans left by the party on Kaul's first visit to the peak were picked up by our party. They were badly mashed and dented by falling stones.

Tuesday morning, June 16, our party left Drake's Springs for the summit of Lassen Peak. The trail leads through a magnificent growth of timber. Above 6000 ft. altitude the traveling was done over hard snow, which as we neared the top became very deep. It easily supported the horses and made the ascent much easier than at other seasons. Even close to the peak only a slight amount of dust covered the snow. In Fig. 2 the shadowy area covering the top of the mountain is dust-covered snow and plainly marks the distance any great amount of dust fell. The lighter-colored portions of this area are bare rock covered with cement-colored dust; the dust upon the snow, being wet, is dark colored.

At 12:30 the ridge at the top was gained and our first view of the crater obtained. The party then descended the slope into the cup-shaped depression that marks the site of the ancient crater. The new crater has broken out on the northwest side of this, and seemingly has

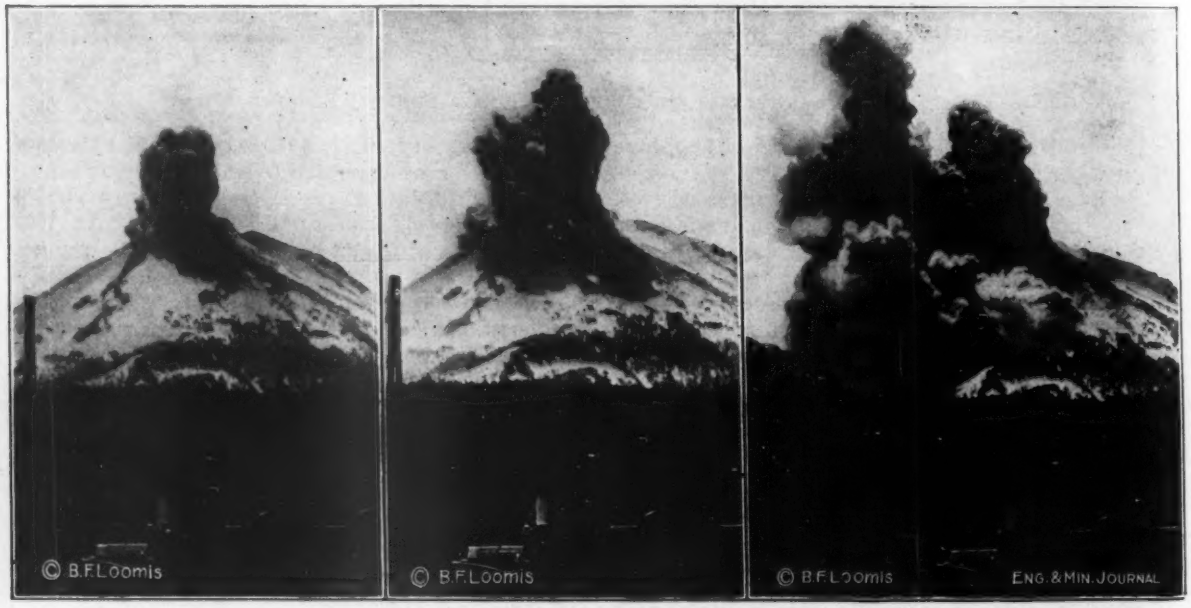


Fig. 1. The Eruption of Mt. Lassen
(Showing successive stages of the smoke column, June 14, 1914.)

*Published by the courtesy of the "Engineering and Mining Journal."

†Mining Engineer, 325 Clunie Bldg., San Francisco.

been formed by steam escaping under high pressure from a fissure which lies along the main axis of the oval-shaped pit. Fig. 3 shows this fissure distinctly. The steam forced its way through the fissure and formed a narrow crater, the sides of which had begun to cave, rapidly widening it.

tain and about a thousand feet from the crater, had its roof perforated in many places by falling rock. The largest hole was 12 in. in diameter and clean-cut.

At the edge of the crater, débris from the different explosions lay on the snow to a depth of three or four feet. This gradually diminished to a depth of 6 in. at the

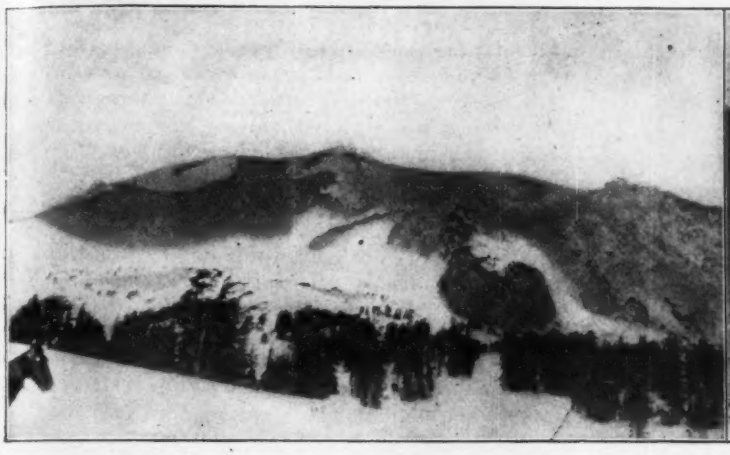


FIG. 2. LASSEN PEAK FROM 8600-FT. ELEVATION
(The dark shading shows where the ash fell on snow; the lighter, ash on shale.)

FIG. 3. THE CRATER
(Track of guide who paced length of crater, at right.)

These pictures were taken at great risk. Aside from the danger of an outbreak of the crater, the danger from the caving sides was great. In order to get good views of the pit it was necessary to go close to the edge. Huge cracks extended back 25 and 30 ft. Every few minutes great masses would fall from the sides. A short time after one of the pictures was obtained, the place from which it was taken suddenly fell into the hole, sending up a cloud of dust and making a spectacular display, which, unfortunately, was over too soon to be photographed, as the party was busily engaged in eating lunch.

The volume of escaping steam varies from moment to moment. In appearance and odor the steam resembles that escaping from the boiling springs which occur along the valley leading up to the peak. That the vapor is steam is evidenced by the fact that it condenses and disappears after rising into the air for a short distance. The hole is about 100 ft. in width and 500 ft. in length. Large quantities of huge rocks have been thrown out. The one in the foreground weighed at least two tons. The deep snow, on the north slope of the south side of the old crater, which was covered with dust, sand and rocks, contained several hundred holes which had been caused by falling rocks. These must have been hot, as they were deep in the snow, which is as hard as ice; also, the sides of the holes are perfectly smooth, and there are many large stones lying on top of the snow beside these holes. Of course, it is possible that the unburied ones did not fall from as great a height as those that are buried. A stone lying 1000 ft. from the crater measured 30x54 in. As it was deeply buried, the thickness could not be measured.

Small heaps of crumbled rock lying on the snow showed that some of the stones crumbled upon being suddenly cooled by it. The lookout station of the forest service, situated on the highest pinnacle of the mountain top of the ridge surrounding the cup of the crater. Upon the snow were stones of various sizes. Next is a deposit of coarse sand, upon which is a layer of very fine dust that closely resembles portland cement. There was no lava or cinders. The only indications of heat were the hot stones and steam. The mountain is composed of dacite, which has the appearance of gray granite. If one could collect the débris from a blast in this rock, he would have exactly the same material that has been cast up by the present eruptions.

The edges of the fissure are covered with a yellow deposit that appears to be sulphur. This could not be verified, as it was impossible to reach the fissure. The presence of sulphur is not unexpected, as deposits of sulphur are found at many of the hot springs in this locality. An odor of sulphur was noticed in the dust, but it was so faint that it could not be determined whether it was the hydride or dioxide.

The evidences on the ground bear out the belief that the material thrown out by the outbursts consisted of débris from the walls of the ancient crater broken and forced from the fissure by steam under great pressure. Much of this material fell directly back into the new crater or caved from the side, closing the vent and making other explosions necessary to clear the outlet of the debris.

Lassen Peak is 10,437 ft. high and is the southern terminus of the Cascade range. Like many other mountains in this range, it was thought to be an extinct crater. In the Lassen lava field, which lies to the northeast and north of Lassen Peak, is situated Cinder Cone, the latest active volcano in the United States. History does not record this last eruption, which appears to have occurred in the neighborhood of 200 years ago. This eruption was so quiet that it would not have attracted attention in a sparsely settled country.

Experiments on the Decarbonation of Water to Prevent Lead Poisoning at Lowell, Mass.

About a dozen years ago the city of Lowell, Mass., virtually abandoned a driven-well water-supply of from 2,500,000 to 4,000,000 gal. daily capacity because the excessive amount of carbonic acid in the water corroded lead service pipes and caused lead poisoning among water consumers. Recent experiments* have shown that this water can be decarbonated and rendered noncorrosive by aëration. Although it is not proposed to make the water usable by this means at present, the experiments are worth recording here briefly, as well as the sort of aërating plant which they indicated would best serve the purpose.

Two methods of decarbonation were available: (1) neutralization of the carbonic acid by lime or soda and (2) removal by iron. The latter proved to be preferable since lime treatment increased the hardness and aëration did not.

Observations were made to show the effect of untreated and treated water on three 50-ft. coils of lead pipe: one pipe for untreated water; one for water treated with lime and one for aërated water. Samples were taken after the water had stood in or been passing through the pipe for 4 hr. and for 15 hr.

LIME-TREATMENT—The apparatus for applying lime is described as follows:

> The apparatus for the addition of lime consisted of a funnel-shaped saturator, 24 in. high and 16 in. in diameter at the top. The lime was slaked in a small receptacle at the side of the saturator and introduced as milk of lime by a pipe which led to the bottom of the funnel. Water was introduced from a calibrated nozzle into a pipe which extended vertically through the center of the funnel to the bottom, the supply of water then rising slowly through the milk of lime and overflowing at the top from a circular weir. The capacity of the saturator was such that when treating 5000 gal. per day of water with 1 grain of lime per gal., the time of passage of the lime water through the saturator was about one hour.
>
> The lime water varied in strength more or less, but on the average contained 1120 p.p.m. of calcium oxide, or 65.5 grains per gal. of this oxide, these figures being based on determinations of the caustic alkalinity of the lime water as it issued from the saturator.
>
> The flow of lime water was maintained at as nearly a constant quantity as possible, and the amount of raw water was varied when it became necessary to change the quantity of lime added per gallon. The lime water was applied to the raw water without exposing the latter to the air, duplicating, as far as possible, the conditions under which, if this method of removing carbonic acid were adopted, the lime water would be discharged into the suction pipe of the pumps.

AËRATING APPARATUS—This was very simple, comprising ⅛- to ¼-in. diameter nozzles, throwing a very fine spray, furnished by the Spray Engineering Co., Boston. Nozzle pressures were obtained by a gage, or, in the case of very light pressures, by a manometer tube.

CHARACTER OF THE RAW WATER—Analyses of the raw water made in September and October, 1913, showed the following averages, expressed in parts per million: Alkalinity, 33.1; total hardness, 55.2; incrustants, 22.1; iron, 0.07; carbonic acid 44.9. For the same period the dissolved oxygen, in percentage of saturation, was 10.9.

RESULTS OF LIME TREATMENT—The standard of results with either method of treatment was taken as a maximum lead content of 0.5. Untreated water standing 4 hr. in the lead pipe took up an average of [illegible] p.p.m. and standing for 15 hr., 6.7 p.p.m., or from 10 to 13 times the safe limit.

It had been hoped that a fraction of a grain of lime per gallon would make the supply safe, but it was found that with approximately 1 grain per gal. (100% of lime available) the water still took up 1.5 grains of lead per gal. after 4 hr. and 3.1 after 15 hr., or 3 and six times the safe limit. With 1¾ grains of lime per gal., the carbonic acid was practically neutralized and the lead content of the water after standing in the lead pipe either 4 or 15 hr. was approximately 0.5 grain per gal. It was finally concluded that 1.5 grains of lime per gal. would render the water safe, since the 15-hr. test was probably more severe than conditions in practice. Even this result was disappointing, for 1.5 grains per gal. of lime would add 45.6 p.p.m. of hardness. This would increase the total hardness by 80%, bringing it up to about 100 p.p.m., "an amount too great to be satisfactory to consumers accustomed to soft New England waters." Table I gives analyses of untreated water after standing four hours in lead pipe.

TABLE I. RELATION BETWEEN CARBONIC-ACID AND LEAD CONTENT OF UNTREATED AND LIME-TREATED WATER AFTER REMAINING IN PIPE FOUR HOURS

	Untreated water		Lime-treated water			
	Carbonic acid	Lead taken up	Lime added		Carbonic acid	Lead taken up
Date	p.p.m.	p.p.m.	p.p.m.	gr./gal.	p.p.m.	p.p.m.
Sept. 2-4	37.5	5.000	16.9	0.99	16.0	2.000
9-11	40.5	5.200	18.5	1.08	19.0	1.400
17-19	38.0	5.200	16.7	0.98	16.0	2.200
23-24	35.5	3.000	16.8	0.98	14.5	1.314
27	....	2.800	17.2	1.00	....	0.914
Oct. 2-3	31.5	4.000	17.4	1.02	9.0	1.828
7	37.5	3.600	17.7	1.04	13.0	1.600
10	45.0	5.200	38.0	2.22	1.8	1.400
17-19	41.5	6.400	35.6	2.08	0.0	0.400
22-23	38.0	4.800	25.8	1.51	6.0	0.714
27-28	42.3	5.200	26.1	1.53	0.0	0.257
Nov. 5	39.0	7.000	29.7	1.74	0.0	0.257
6-3	41.5	8.000	29.1	1.71	1.8	0.943
12	36.0	4.600	29.5	1.73	0.0	0.400
13	37.5	5.200	25.5	1.49	0.0	0.800

p.p.m. = parts per million.

RESULTS WITH AËRATION—Dismissing lime treatment as "undesirable and uneconomical," the report next discusses the results with aëration. These indicate that aëration by fine-spray nozzles "is very effective in the removal of carbonic acid, although the time during which the spray is in the air is short." The tests also indicated that with a 5-lb. nozzle pressure "the carbonic acid can be reduced from 45 p.p.m. in the raw water to about 3.3 p.p.m. in the aërated water, and that with this reduction, the effect of the water on lead pipes is so far lessened as to render the supply safe."

Table II gives analyses of aërated water which had stood 4 hr. and 15 hr. in lead pipes.

TABLE II. RELATION BETWEEN CARBONIC ACID AND LEAD CONTENT IN AËRATED WATER AFTER REMAINING IN PIPE FOR 4- AND 15-HOUR PERIODS

	4-hour sample		15-hour sample	
Date	Carbonic acid	Lead taken up	Carbonic acid	Lead taken up
Sept. 9-11	3.0	0.114	3.5	0.571
17-19	3.5	0.457	3.0	0.543
23-24	4.5	0.657	3.5	0.800
Oct. 2-3	3.5	0.457	3.0	0.657
7	3.5	0.400	4.5	1.143
17-19	4.0	0.400	3.5	0.400
22-23	16.0	0.400	13.0	0.743
27-28	17.0	0.600	16.0	0.886
28	3.0	0.343	....	.....
Nov. 6-8	10.0	0.343	9.5	0.943
12	22.0	0.943	17.5	1.143
13	3.0	0.257	....	.....

All in parts per million.

*This article is based on a report on "Improvement of the Water Supply of the City of Lowell, Mass.," made in June, 1914, by F. A. Barbour, Consulting Engineer, Boston, Mass. James H. Carmichael is Water Commissioner and Robert J. Thomas is Superintendent of Water-Works, Lowell, Mass.

The report sums up the decarbonation studies and gives an estimate for an aërating plant as follows:

The removal of carbonic acid by aëration has a great advantage over the lime treatment in that it does not increase the hardness, and further, as indicated by the tests, aëration is more effective than the lime treatment in reducing the corrosive action when an equal amount of carbonic acid is left in the treated water. This result is not what might be expected, because by aëration the dissolved oxygen, which has generally been considered a contributary factor in corrosion, is increased, but the experiments clearly indicate that, with an equal content of carbonic acid, the aërated water takes up less lead than the lime-treated water.

An aërating plant, if constructed, would include a pipe system into which the necessary number of nozzles would be tapped, a concrete pool, and below the pool, a small storage basin with a capacity of perhaps one hour's run of the pumps. The water, as drawn from the wells, would be forced through the aërator, and after falling into the storage well, would be repumped into the distribution system.

It is estimated that the first cost of an aërator, storage well and new steam turbine centrifugal pumping unit of 4,000,000 gal. daily capacity will be approximately $25,000. Assuming that the installation of the aërator will involve an additional lift of 30 ft., the cost of aërating the water will not exceed $225 per 1,000,000 gal., including interest, depreciation and the cost of extra pumping necessitated by aëration. This cost is less than the cost to consumers for additional soap, which would necessarily be used if the carbonic acid were neutralized by lime treatment, and it therefore follows that aëration is the more economical method.

Water from the Cook wells, as this group of wells is called, could be used for summer-peak consumption to supplement the Boulevard-well supply, which Lowell now proposes to treat by (1) coke prefilter operated as a contact bed; (2) sedimentation; and (3) sand filtration for iron- and manganese-removal, as outlined in our issue of July 9, 1914.

Oscillating Signals for Grade Crossings

The demand for greater protection to road traffic at railway grade crossings has led to the designs of signals with special features to compel attention. Such signals are specially desirable where there is much automobile traffic, as the cars approach at high speed and a sign or gate (or even a flag) may not be very conspicuous, while the noise of the engine may prevent the driver from hearing the sound of a train, whistle or ordinary crossing bell.

A crossing signal of this kind which was developed in California and has been applied extensively on steam and electric roads, combines sound, movement and light as means of attracting the attention of highway traffic when a train is approaching the crossing. The accompanying cut shows two of these signals installed recently at the 7th Ave. crossing of the Chicago Great Western Ry., at Maywood, Ill. The steel post is surmounted by a fixed bell of the locomotive type and carries a bracket arm from which is hung a 2-ft. disk having a pendulum movement imparted by mechanism contained in the box at the end of the fixed arm. The disk is swung through an arc of about 3 ft. in length, and makes 40 to 60 strokes per minute.

The disk is hollow, made of two conical plates, enameled red on the outside and white inside (as a reflector), and having a red signal lens in the center of each side. The disk is lettered on each side "Danger, Stop," the former word being in white, while the latter is formed in 6-in. letters of white glass "jewels." In the hollow disk are placed two incandescent lamps (so that if one burns out the light feature of the signal will still be operative); These illuminate the red lens and the word "stop." With the brilliant lights, the swing of the disk, and the sound of the bell, the signal is made very conspicuous, and attracts attention at a considerable distance.

The disk-swinging mechanism and the lights are operated from the electric-light mains, while the bell is operated from a local battery. The bell mechanism and the lights are operated (independently) from the track-control instrument, which is placed 2000 to 3000 ft. from the crossing and is operated by the train. Thus a defect in any one of the three means of warning does not affect the others. The signal can be operated on alternating or direct current and on voltages of 8 to 12 or as high as 110 to 550 volts. The disk mechanism may be operated from storage batteries, lighting circuits or trolley circuit. On steam railways, the rails for the desired distance are charged with current from a battery, the train completing the circuit and operating a relay which connects the motor with the power circuit. On electric railways, the connection to the motor may be made through

GRADE-CROSSING SIGNAL WITH AN ILLUMINATED SWINGING DISK AND A LOCOMOTIVE BELL

a contactor on the trolley-wire or third rail, and operated by the car, while a second contactor serves to break the connection.

The signal was designed to serve as an automatic flagman. In the original form the mechanism and a gong were mounted on top of the post, with the disk on a rod extending vertically above it. But by putting the disk on a bracket at the side, it is made more conspicuous to drivers in the street or road. About 1700 of these signals are in use. The signal has been developed in its present form by the Railroad Supply Co., of Chicago.

Two other forms of swinging or "wig-wag" crossing signals are in use, but to a more limited extent. One of these has a pendulum disk (with central lens and inclosed lamp) hung from an arm of the post, while the post also carries a loud gong or bell. This is a specialty of the Bryant Zinc Co., of Chicago. In the third signal, the post is surmounted by a swinging bell, the shaft of which carries two small red swinging blades; these have a limited travel and are for the day indication only. At night, a lamp mounted in a hood above the bell gives a flashing red light while the bell is ringing, and there may be a crossarm with "Danger" in flashing red letters. This signal, which is made by the Hoeschen Mfg. Co., of Omaha, Neb., has no battery. It has metallic circuits to

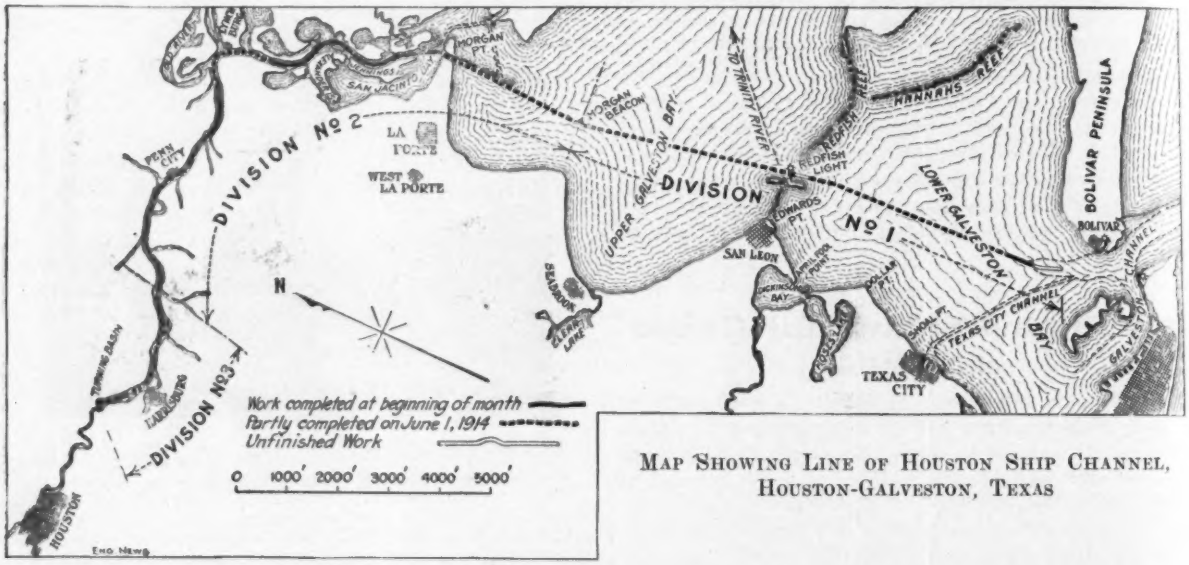
magneto generators placed at the desired distance and operated by the deflection of the rails under passing wheels. The signals may have an electric lamp or a long-burning oil lamp for use on steam railways.

The Houston Ship Channel

By Charles Crotty*

The Houston Ship Channel is the name of the improvement now under way to provide a ship channel to connect the City of Houston, Texas, with the Gulf of Mexico, and to provide a new port for the handling of the growing commerce of the Southwest.

The channel extends from Galveston Harbor opposite the inner end of the jetties and upper end of Bolivar Roads, in a northwesterly direction across lower and upper Galveston Bay, San Jacinto Bay and River; entering Buffalo Bayou at Lynchburg, thence up Buffalo Bayou, past the historic San Jacinto Battlefield, to the head of Long Beach, about two miles above Harrisburg, ending in a turning basin which is about seven miles below Houston's business center by water and about 4½ miles in a straight line. The total length is 50 miles, of which 25 miles is in Galveston Bay.



Map Showing Line of Houston Ship Channel, Houston-Galveston, Texas

In their natural condition prior to improvement, these waterways had a depth of about 9 ft. in the lower and about 7 ft. in the upper Galveston Bay, 10 to 20 ft. in the San Jacinto Bay and River, with low marshy banks and a width of 500 to 800 ft. and 10 to 15 ft. in Buffalo Bayou, with gradually raising banks from 6 to 40 ft. at the turning basin and widths of 200 to 500 ft. The material consists of mud, sand and clay, with some shell through Galveston Bay, sand and clay of varying colors and hardness through the river and bayou.

For convenience and division of contracts the waterway has been divided into three general divisions, No. 1 extending from Bolivar Roads to Morgan Beacon, about 20 miles long and 5½ miles from upper end of bay at Morgan Point; No. 2 extends to the mouth of Vince's Bayou, and is about 25 miles long, and No. 3 thence to turning basin 5 miles, though what is usually known as the Houston division from turning basin to foot of Main St., Houston, a distance of 7 miles is really a part of Division 3.

The earlier projects for the improvement of this natural waterway, which were adopted in 1871 to 1892, provided for a channel 100 ft. wide and 12 ft. deep, dredging being carried on for a number of years in removing shoals to attain this depth, which was sufficient for the character of vessels then navigating these waters. The Morgan Line began operating steamships and sailing vessels between New York and Houston as early as Apr. 21, 1876, when the "Clinton" passed up the channel and docked at the wharves at Clinton, a few miles below Houston where a branch line of the Texas & New Orleans R.R. connected with the city and other railway lines.

Considerable traffic was carried on for many years, until the increased size and draft of the vessels outgrew the development of the channel and they were forced to seek ports with deeper water.

The existing project, as adopted in 1899, and modified in 1905, provided for the completion of the ship channel to a depth of 25 ft. and width of 150 ft. across Galveston Bay, with slopes of 1 vertical to 3 horizontal, and width of 100 ft. in river and bayou, with slopes of 1 vertical to 2 horizontal, and a turning basin 600 ft. in diameter on the bottom.

As a part of this project the channel was dredged in 1903-05 to a depth of 18½ ft. under contract with the Bowers Southern Dredging Co., of Galveston, Tex., at the rate of 8.8c. per cu.yd. in Galveston Bay and 14c. per cu. yd. in river and bayou. This depth was obtained as far as Harrisburg.

In 1906, contract was entered into with the Atlantic, Gulf & Pacific Co. for the dredging of Division 3 above Harrisburg and the excavation of the turning basin, at the rate of 19.9c. per cu.yd. Under the various small appropriations from year to year, this work, and the removal of several sharp bends by contract and Government dredges, the entire channel was completed to a depth of

*U. S. Superintendent, in charge of field work and supervising dredging operations, Houston Ship Channel, La Porte, Texas.

18½ ft., though the shoaling in Galveston Bay of several feet prevented its use by deep-draft vessels.

In view of the fact that previous appropriations had not been in sufficient amount to insure the completion of the channel to its full depth of 25 ft., its entire length, at one time and make it available for practical use, the citizens of Harris County, through their Deep Water Committee, proposed to the Rivers and Harbors Committee in Congress that they would be willing to contribute one-half of the funds required to complete the work if Congress would make a large enough appropriation and enter into contract for the prompt completion of the project.

Acting on this proposition, Congress, in June, 1910, appropriated $300,000 and authorized contracts for $2,500,000 provided that Houston interests would contribute one-half of the cost of the work, or $1,250,000, and provided that any contract entered into must specifically provide for the completion of the project.

The Harris County Houston Ship Channel Navigation District was then created, taking in the entire county, bonds were voted and sold, the money being turned over to the United States early in 1912.

Under this authorization contract was entered into on June 19, 1912, with L. T. Gaylord, representing the Atlantic, Gulf & Pacific Co., of New York, for the dredging of all three divisions, and providing that on completion of the work the contractor should turn over to the United States a channel the full depth of 25 ft. from end to end, and width of 150 ft. in Galveston Bay and 100 ft. in river and bayou, the slopes to be as steep as the material would stand with payment to be made for excavation within 1 on 3 in bay and 1 on 2 in river and bayou. This placed the responsibility of maintenance until completion of contract upon the contractor, and insured the obtaining of a finished channel its full length at one time.

The contract rates are 6.95c. per cu.yd. in Div. 1, based on estimated quantities of 10,538,000 cu.yd.; 14.9c. per cu.yd. in Div. 2, based on 6,100,000 cu.yd., and 18c. for Div. 3, based on 4,025,000 cu.yd.

Work was started June 15, 1912, with one dredge, a second was added Aug. 4, the third Aug. 31, the fourth Nov. 17 and the fifth on Dec. 28, 1912. The fleet was kept on Divisions 2 and 3 until they were practically completed, Division 1 across the bay being left until last. To June 1, 1914, these five dredges have excavated a total of 20,027,418 cu.yd. of material from within the prescribed cross-section, and a gross total of 28,788,596 cu. yd., including overdepth, outside of slope lines, etc., beside the removal of silt and shoals over about 17 miles of Division 2 in final clean-up of which no accurate record has been kept.

The first cut was completed June 15 and all the fleet massed on the clean-up work, which it is expected will be finished about Aug. 1, 1914, and the channel opened up for navigation about a year and a half in advance of the time allowed under the contract.

The plant engaged on the work is of the most modern and efficient type of hydraulic suction pipe-line dredges, and consists of the following: "Geo. W. Catt," steel hull, 27-in. suction, 24-in. discharge; "Texas," "Washington" and "Pensacola," with wooden hulls, 22-in. suction and 20-in. discharge pipes, belonging to the Atlantic, Gulf & Pacific Co.; and the "Galveston," wooden hull, 22-in. suction, 20-in. discharge, and the "Houston," a new wooden hull, steam turbine, electrically driven pump and cutter engine, 24-in. pump and 22-in. discharge pipe, belonging to the North American Dredging Co., of Galveston, Tex.

The largest output for any single month was made by the "Texas," which excavated 1,261,646 cu.yd. of mud, shell and sand, completing a channel 150 ft. wide and 9100 ft. long, pumping through about 1200 ft. of pipe line working in Galveston Bay. The dredge "Houston," equipped for high speed and lifts, handled 222,861 cu.yd. through a pipe line 3800 ft. long and with a lift of 36 ft. while working in the turning basin. A large part of this material was hard red clay, the rest mud and sandy loam.

For the maintenance of the channel after the completion of this contract, two large hydraulic suction-pipe-line dredges are being built under contract with the Bowers Southern Dredging Co., of Galveston, Texas, at a cost of $320,000 for the two. The steel pontoons, pipe lines and other equipment will probably bring the cost up to about $400,000, of which one-half is contributed by the Navigation District.

The completion of this channel will allow vessels to reach a harbor 50 miles closer to the point of production of the greater part of our commodities, and to form connection with the seventeen railways centering at Houston, will provide for the expansion of the growing business of the Southwest and create a great inland, fresh-water harbor, develop industries along its route by furnishing cheaper transportation for raw and finished products, and with pipe-line connection to the fuel-oil fields of Texas and Oklahoma, the opening of the new iron-ore fields of northeast Texas, the early completion of the Intra-Coastal Canal enabling coal barges to be brought from the fields of Alabama, and along the Ohio River, it is expected that a new era of business development in manufactures will take place.

Cotton is still the greatest single item of export and about 400,000 bales have been handled over this channel each year by barges, while about 5,000,000 bales per year have passed through Houston to be loaded on vessels at Galveston and Texas City. It is expected that Houston, with the many compresses and warehouses of the most modern fireproof type that are now built along the channel and between the turning basin and the city, will be able to load a great deal of this commodity into vessels in her own harbor.

The recently created Harbor Board of Houston is now working up plans for the construction of the latest type of wharves, warehouses and freight-handling machinery, to be erected in units as the needs of commerce justify, beginning at the turning basin, and working down the channel. As the waterway connects with other streams and lakes there is available for improvements about 75 miles of water front, with close rail connection, and with its ultimate enlargement as the business grows and the Western country becomes more thickly settled and productive the possibilities for the future as a port are unlimited. Of course, Houston expects to reap a considerable share of the trade developed for this section of the country by the opening of the Panama Canal.

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Street Pavement Work in Zanesville, Ohio, will amount to nearly $200,000 for the period since the great flood of 1913, according to statistics recently published in the local newspapers. About $50,000 is being spent on the sewerage system.

Putting 13-In. Pins in Place of 10-In. Pins, Williamsburg Bridge

By O. E. Hovey*

In the May 14, 1914, issue of Engineering News, reference was made to "the sensational performance of taking out a 10-in. bridge pin and putting a 13-in. pin in its place" on the Williamsburg Bridge, and a brief outline of the general method adopted was given. The writer believes that a further account of this unusual piece of work will be of interest to engineers.

The Problem

The Williamsburg suspension bridge, crossing the East River at New York, is so designed that the portions of the main cables extending from the tops of the towers back to the anchorages carry no load from the land spans. These spans are supported by steel towers. Fig. 1 shows the general arrangement. The stiffening trusses of the main span are continuous between the towers and are supported on rocking links at the towers; the trusses continue landward of the rocker supports for a distance of 23½ ft., or one panel, as cantilevers. In the original construction, these cantilevers consisted of a single triangle at each end of each truss, *L*-29 *L*-30 *U*-30, in Fig. 2, carrying the land span at *L*-29 by a 10-in. pin.

On account of this unusual construction, all motions of the cables of the main span up or down, due to contraction, expansion, or live-load variations, cause points *L*-29 to move down or up. Also, contraction or expansion of the stiffening trusses causes points *L*-29 to move horizontally toward or from the towers (the stiffening trusses being free to move on account of their rocker supports); such horizontal motions are communicated to the land spans at both ends of the bridge, and cause tension or compression across the points *L*-29. These stresses are further increased by horizontal or wind stresses, since the main lower chords are also the wind chords.

The general strengthening of the bridge for subway trains, recently completed, required various additional members and connections. Those at panel-point 29 are shown in Fig. 2. The original cantilever has been strengthened by the addition of triangle *U*-29 *L*-30 *U*-30. A portion of the load from the land span has been permanently transferred to the new triangle by means of a new transverse lattice truss attached to the land span at point *U*-29 and resting on adjustable wedge bearings on the new cantilever triangles at *U*-29. This construction is shown by Fig. 2.

It was also necessary to replace the old 10-in. pins at *L*-29 by new pins 13 in. in diameter. To do this, the old 10-in. pin-holes must be enlarged to 13 in. in diameter, with all connecting main members in position. On account of the difficulty of removing the chips produced by the boring operation by any other method, it was decided to remove the old 10-in. pins and enlarge the holes by open boring and the use of a boring head fed along a boring bar, if a safe method of procedure could be developed.

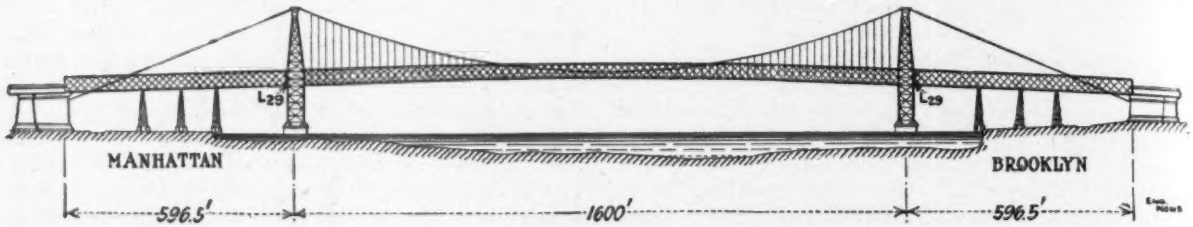


Fig. 1. The Williamsburg Bridge as Strengthened by Additional Towers in Shore Spans

*Assistant Chief Engineer, American Bridge Co., 30 Church St., New York.

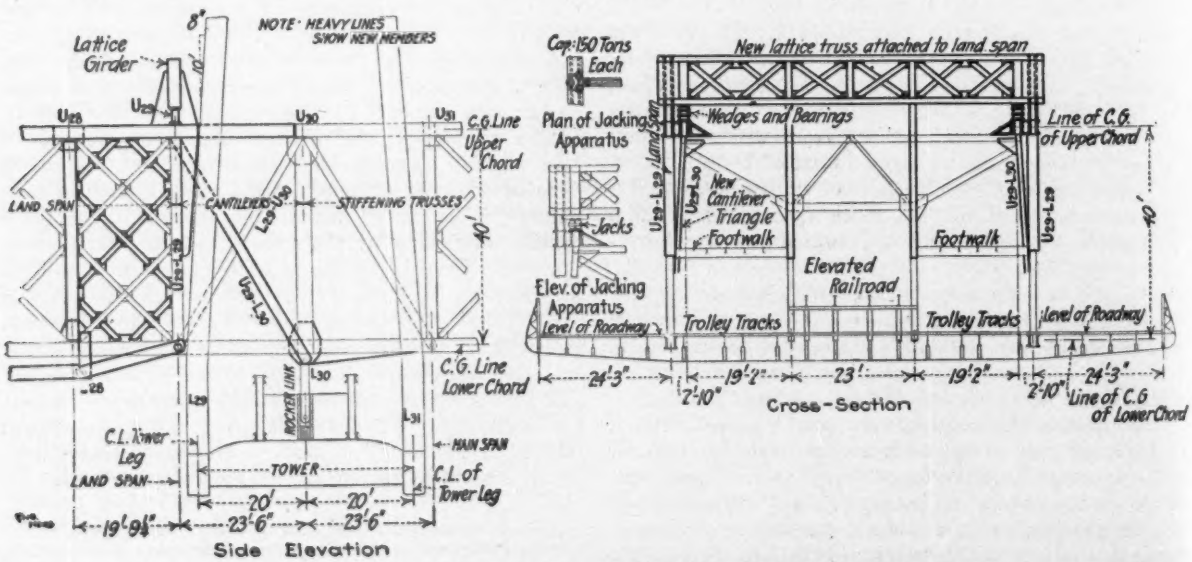


Fig. 2. New Members near Panel-Point 29, Williamsburg Bridge

To relieve the 10-in. pins of vertical load, the new wedge bearings at *U*-29 could be temporarily replaced by hydraulic jacks and blocking, by which means the load of the connecting spans could be temporarily transferred from the old cantilever triangle *L*-29 *L*-30, *U*-30, to the new triangle *U*-29 *L*-30 *U*-30, in Fig. 2. Longitudinal movements at *L*-29 could be temporarily suppressed or at least reduced, by stopping trolley and vehicular traffic during the early morning hours of certain nights. As the bridge is a very important traffic link, it was imperative to make the stoppage of traffic as brief as possible. This demanded the development of a device to enlarge the holes quickly, and effective guarding against all unnecessary delays during the boring operation.

Locking Joint *L*-29

It was obvious that the boring, with the old pins removed, would not be successful unless the connecting members were held in fixed relative positions during the entire operation of removing the old pin, enlarging the holes and driving the new pins. It was also necessary to arrange for connecting the new wind chords *L*-28 *L*-29 on the new pins, and further to provide for stresses at the joint due to temperature changes and lateral wind pressure.

The lower chords were prevented from moving toward each other by driving wedges in the clearance spaces between them. They were held from moving apart by two tie-rods 3½ in. in diameter, fitted to temporary brackets on their bottom flanges. The three intersecting members of the land span were already connected by heavy gussets inside of the posts *L*-29 *U*-30. But the members *L*-29 *L*-30 and *L*-29 *U*-30 of the old cantilever were connected only by the pin; therefore, triangular brackets were provided to attach these members rigidly together and to stop relative angular motion. It was then only necessary to furnish heavy struts to join the land span to the cantilever in order to stop all relative motions at this joint. To prevent the thrust of the boring head from pushing the members together, transversely with the trusses, small wedges were driven in the clearance spaces between them. The design of these devices for locking joint *L*-29 against all motions is shown in Fig. 3.

To further guard against any possible motions at *L*-29, the upper chords of the land span and the stiffening truss cantilever were locked by struts and tie-rods, as also shown in Fig. 3.

All of these temporary parts to lock the joint against motions were carefully fitted up on the bridge in advance and adjusted loosely so as not to interfere with the normal movements of the bridge until everything was ready for the removal of the old pins.

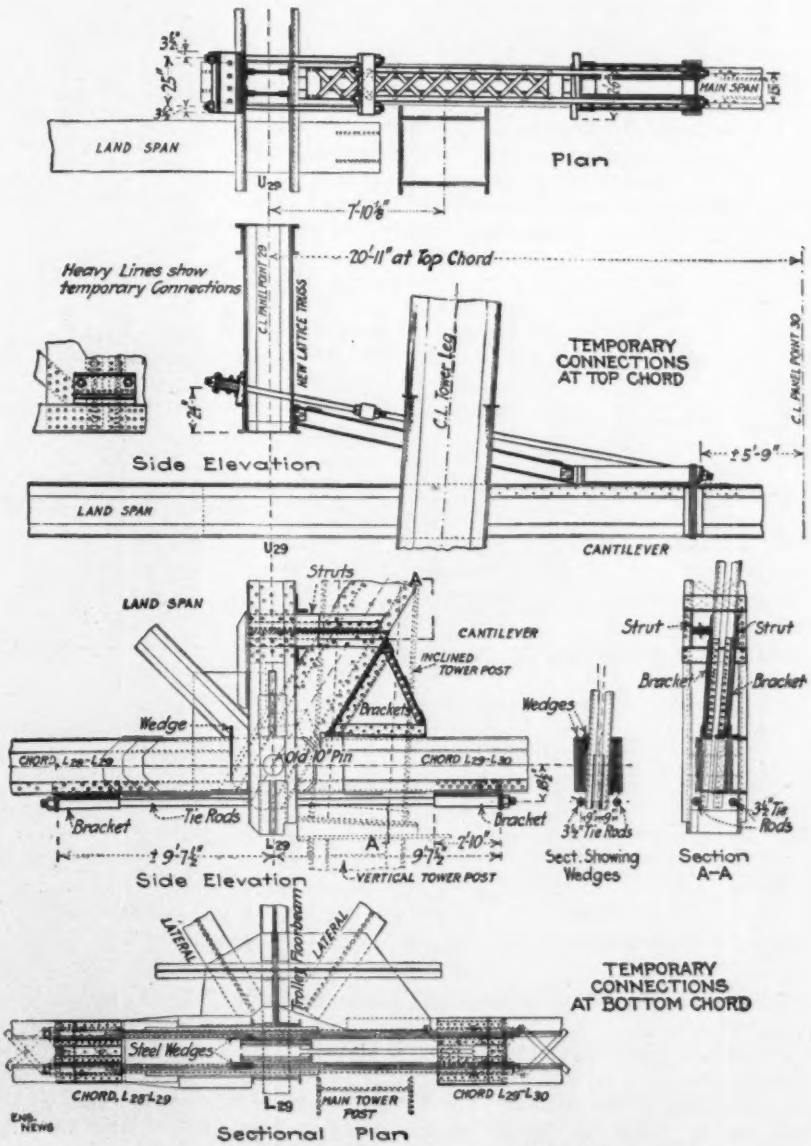


Fig. 3. Temporary Connections to Hold Joint L29 Rigid While Boring Out the Pin-Hole

It was found that the old pins could not be backed out, as they had been driven very tight and some corrosion had occurred, thoroughly cementing them into the ends of the holes. The pins were therefore collapsed by boring axial holes along the horizontal diameter and chipping away the walls between the holes. The half pins were then loosened and wedged back in their original positions, so that when all was ready they could be quickly removed.

Boring Machine

The design of the boring machine for enlarging the holes presented an unusual problem. Pins *L*-29 are very near the main tower legs, and the clearance was so limited that the machine had to be placed on the landward side of the hole. This meant inverting the machine from right handed to left handed when changing from south truss to north truss or *vice versa*. It was vital that the machine should be so made that it could be attached to the bridge and carefully aligned in advance, and clearance provided so that the old pin could be taken out, the boring bar put in and removed, and the new pin driven without disturbing the main frame and the alignment of the machine. It must be as compact as possible to avoid having to cut a large hole in the roadway floor. As the amount of steel to be bored out was about 1300 cu.in., ample strength, stiffness and power were necessary. The removal of 1300 cu.in. in one hour (over 6 lb. per min.) runs in a groove milled in the bar, and is driven by gears in the feed head *O*. The fixed pinion *P* is boxed in the plate *R*, which is attached to the fixed boring-bar box *K* by studs *S*. The shaft carrying pinion *P* is fitted with a handle which was locked to the plate *R*, thus providing automatic feed of the screw due to rotation of the boring-bar. To stop the feed, this handle could be unlocked, allowing gear *P* to rotate, thus stopping the action of the feed train.

In ordinary practice, the tool head is fed along the bar toward the feed mechanism. Clearances prevented this being done, and to keep the feedscrew in tension, it was necessary to provide a thrust bearing at the extreme outboard end of the bar. This thrust bearing is of bronze, with 12 collar bearings, each lubricated by means of a central oilhole in the boring bar, with branches to each collar, and supplied from a grease cup in the end of the bar.

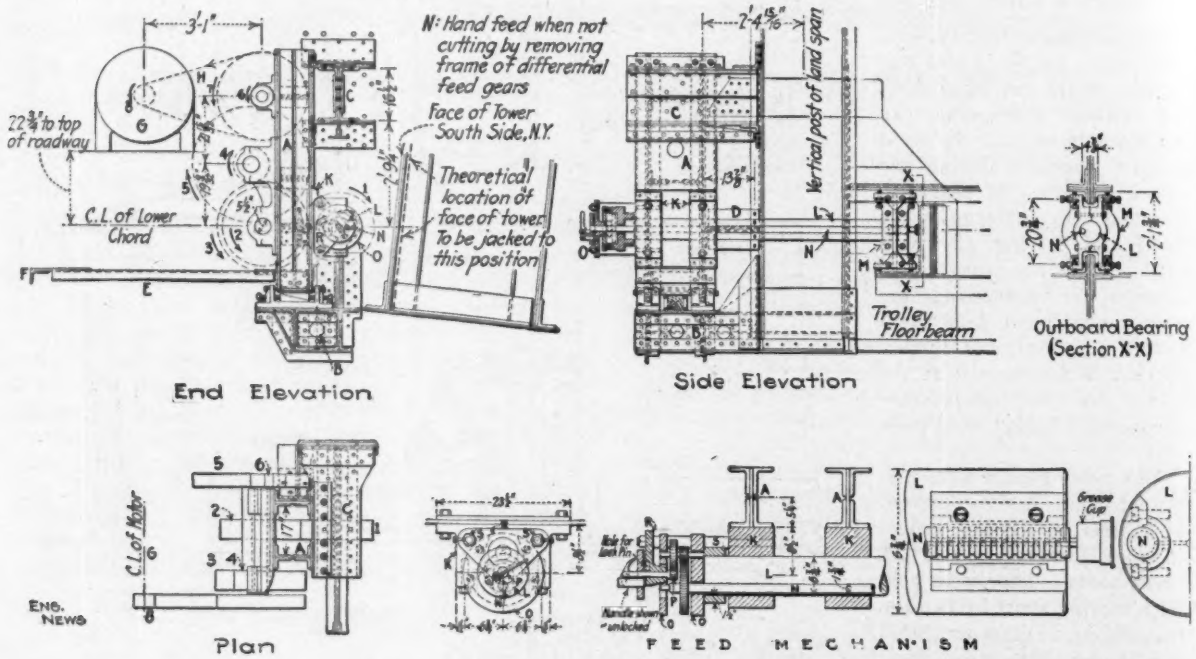

N: Hand feed when not cutting by removing frame of differential feed gears
Face of Tower South Side, N.Y.
Theoretical location of face of tower. To be jacked to this position
C.L. of Lower Chord
End Elevation
Vertical post of land span
Trolley Floorbeam
Side Elevation
Outboard Bearing (Section X-X)
C.L. of Motor
Plan
FEED MECHANISM

Fig. 4. Special Pin-Hole Boring Machine

in the form of spiral chips, required ample space for their successful removal.

To provide for convenient attachment to the bridge superstructure and for assembling alternately right and left, the frame of the machine (Fig. 4) is a structural-steel post *A*. This was attached to the bridge by steel brackets *B*, *C* and *D* and braced by the strut *E*, bolted to a bracket bolted to lower chord *L*-28 *L*-29. On the back of the frame is a gear train, *2*, *3*, *4*, *5*, *6* and 7, driven by a 35-hp. motor *G*, by a 4-in. Morse chain *H*, engaging sprockets 7 and 8. The front of the frame is left clear for the boxes *K* and gear *l* of the boring bar *L*. To the bridge floor-beam was clamped an outboard bearing *M*, one-half of which could be removed for inserting and removing the boring-bar without disturbing the alignment of the bearing.

The boring-bar is 6¾ in. in diameter, and 7 ft. 11 in. long as assembled. A feed screw *N*, 1¾ in. in diameter,

The boring head carries seven self-hardening, high-speed steel tools. Six of these were so set that each made a circular cut ¼ in. wide. The tool taking the cut from 10-in. to 10½-in. diameter was set in advance of the next from the center and so on for the six. The seventh tool took a light finishing cut. The assembled boring-bar as it was handled in and out of the hole is shown by photograph, Fig. 5.

The Boring Operation

All preliminary operations having been completed in advance, on the nights set for changing the various pins a force of picked men, each specially instructed in his duties and working from a carefully prepared schedule of operations, was assembled on the bridge and at the time fixed to begin work all trolley and vehicular traffic was stopped and the work begun. At each of the four points the work was completed well within the time allowed.

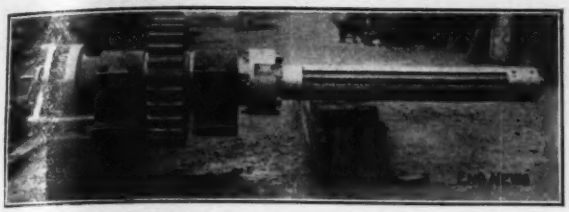


FIG. 5. BORING BAR

The following gives the record for each point:

Point	Date 1914	Traffic stopped	Traffic resumed a.m.	Total time hr.	Total time min.	Time first cut min.	Av. hp.	Steel removed, lb., per min.
Manhattan south.....	Apr. 12	1.00 a.m.	5.50	4	50	60	26.9	6.15
Manhattan north.....	Apr. 26	25th; 12.20 p.m.	3.45	3	25	58	22.6	6.35
Brooklyn south.....	May 16	15th; 12.25 p.m.	3.30	3	5	57	22.5	6.46
Brooklyn north.....	May 29	28th; 12.15 p.m.	3.30	3	15	58	21.4	6.35

The boring machine assembled on the bridge is shown by the flashlight photograph, Fig. 6, in which the boring head is seen just entering the vertical post.

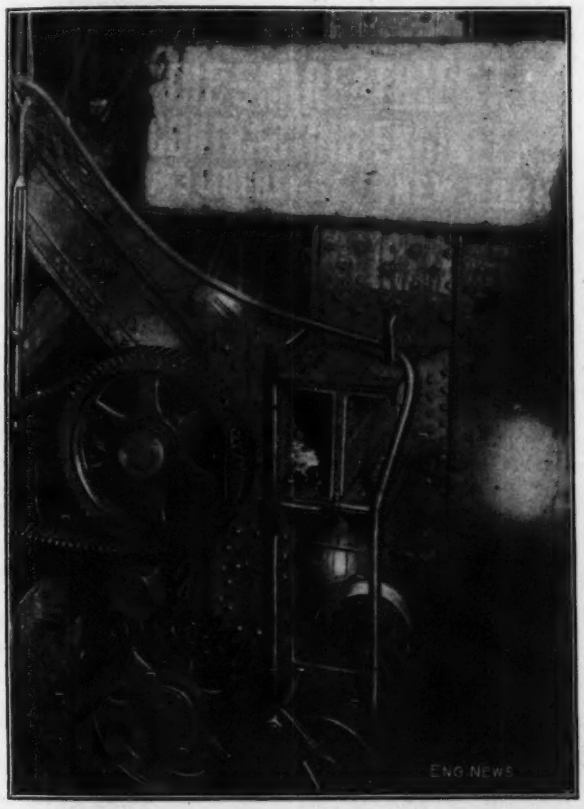


FIG. 6. BORING MACHINE

This work was done by the Snare & Triest Co., of New York, under a contract for strengthening the end spans of the Williamsburg Bridge, and under the direction of the Department of Bridges of the City of New York.

The devices for locking joint *L*-29 against motion, and the boring machine, were designed by the writer, who was retained by the Contractors as Consulting Engineer.

The boring head was developed by Martin Joachimson, Assistant Engineer of the Bridge Department, in consultation with the writer.

The Old Wooden Bridge

[The excellent parody on Longfellow's "Evangeline," printed below, we take from the June "Bulletin" of the Iowa State Highway Commission, which credits it to the Manchester (Iowa) "Mirror," where it was printed anonymously. Such bridges as are well described in the verses exist, however, in hundreds of country towns beside Manchester.

It is fair to say, however, that while there are many such rotten and rickety wooden structures which ought to be replaced in the interest of safety, there are still localities where the wooden truss bridge is probably the best structure that can be built; and many old wooden bridges, properly protected from the weather, have had a useful life longer than that of many steel bridges.]

This is the structure primeval; the tottering beams and the timbers,
Patched up with boards and with fragments, old, frail and fearful to look at,
Stand like ruins of Rome, with memories sad and prophetic;
Stand like a pile of junk that no one will take for the hauling.
Loud from the rickety boards, the ancient nails all together,
Shriek, and in accents disconsolate, answer the curse of the traveler.

This is the structure primeval; but where are the hands that in old times
Wielded the hammer and saw, and fashioned its lines full of beauty?
Where are the boys of the village that leaped from the rail in bravado?
Where are the maidens of those times, who made sand cakes in its shadow?
Gone to their final home, but the bridge in rotting decadence,
Marks for all who can see, the date when our city was founded.

Dear to the hearts of the Council is this relic received from the ancients;
Precious is each piece of punk secured by rust to the ruin;
Ten-penny nails in rich measure adorn every spot that will hold them;
Boards of all kinds, wire and rocks give grace in fullest profusion.
Think not that money is lacking to furnish a structure more modern—
Money is raised every year, and spent where the aldermen wish to;
Near to their hearts and their homes have they laid out their lines of improvement,
Trim and neat is our city, wherever the "drag" has been working.
No, this bridge is preserved, a dangerous trap for the user,
Likely to cost many times the price of a new and secure one,
A monument, always to stand, to the wisdom and pride of our Council,
Showing the different styles of nailing supports to a ruin,
Showing to all the world the power that lies in the Council.

Field and Office

A Drafting-Room Innovation: Drawing with Steel Point on Coated Paper

A proposal to revolutionize drafting-room practice is just being put forward in practical working form. Drawing paper and tracing cloth, pencil, pen and ink are to be abolished. In their place is to come a dark-coated fabric and a steel scriber; to make a drawing, use the scriber as a pencil and scribe the drawing on the coated fabric, producing white (and *translucent*) lines on the dark (and opaque) fabric. Blueprints are made direct from the finished drawing.

Charles H. Little, of Cleveland, Ohio, worked out the new appliances, in pursuit of the idea that double work —drawing and tracing—is superflous and ought to be abolished. He says that very many trials and experiments were required to find the right base (paper or fabric), the right coating, and the right scriber. Now that the work has reached the point of practical success, Mr. Little's company, the Universal Drafting Machine Co., Cleveland, is putting the fabric and scribers on the market. The fabric is called Unidraft Fabric, possibly in reference to the elimination of double work.

THE FABRIC—The surface of the coated fabric is resistant enough that it does not become scratched in working on it and handling it; yet it takes the scriber marks easily, with just enough resistance to permit of varying the width of line by controlling the scriber pressure. Figs. 5 and 6 show lines of different strengths. The surface is dull, and does not reflect a glare into the eyes. Also, the color (dark brown) gives it one great advantage over paper and tracing cloth: the eye is rested where it looks at the general surface, and only the narrow width of the scribed lines is *seen*. This not only is restful to the eye in a general way, but it makes it very easy for the draftsman's eye and mind to follow the drawing, for the same reason that a lantern at night strikes the eye much more quickly and surely than does a black object in daytime. The fabric is claimed to eliminate the eye-strain question (always important with draftsmen), and that the unsolved problem of satisfactory drafting-room lighting ceases to exist.

A cloth base for the coating is preferred to a paper base, although the latter was tried out extensively in the course of the development work. The durability due to the cloth base, and the freedom from soiling due to the dark, nonabsorbent surface, are distinct advantages where a drawing is worked on for a length of time.

THE SCRIBER—Various forms of scribers have been tried. The one shown (magnified three or four times) in Fig. 4 is the preferred form, being most widely adaptable. It is held with the cylindrical side leading, the beveled face standing about vertical (handle inclined forward, as in Figs. 1 and 3); the trick of using it is learned easily, as we have had occasion to prove.

Circles are drawn just as easily as straight lines, scriber points being inserted in compasses and bow instruments. Fig. 2 illustrates the work of drawing circles with bow compasses. Here also the width of line is controlled by pressure variation, same point being used throughout.

The scriber shown answers all requirements as to drawing lines. It is also satisfactory for lettering, but in this part of the work individual preferences and habits of the hand are a consideration. A scriber of cross-shaped section, ground off on a bevel like the one shown, is also an efficient tool in lettering. The important fact as to lettering is that a little practice enables one to letter just as rapidly and neatly with the scriber as with the pen.

By eliminating ink, the work of drawing on this fabric is clean, quick work; the draftsman does not wait for ink to dry, or run the risk of making a smear. This fact alone means great saving of time, enough to make up for any other differences of facility between scriber and pen.

ERASURES—To erase lines or marks from the fabric, it is only necessary to draw or mark over them with pen and ink. The white under-coating takes the ink; the black or dark-blue coloring of the ink is hardly distinguishable against the brown, in looking at the surface, while for blueprinting purposes the erasure is completely effective.

Another line or mark can be made over the erasure, by again using the scriber, which cuts away the ink, together with some of the under-coating.

The erasure process is much quicker and easier than erasures on tracing cloth, and in certain cases may be quicker and more convenient than erasing pencil marks or lines. Thus, taking out part of a line in a crowded part of a drawing is easy with the fabric, while in pencil work it will require redrawing some lines erased unintentionally. Converting a full line into dashed or dotted is also very easy in the case of the fabric.

The facility of erasure is apt to be an important question with those who are accustomed to making drawings by the trial-and-erasure process. For work of this kind, the applicability of the fabric is rather limited. Its primary field is that class of work in which the arrangement and layout of the drawing is well fixed in advance, as in detail work, shop drawings, etc. Especially where the edges of the rules bear scales, as in the drafting machine, there is a constant guide to the line work which is of value in the most efficient use of this fabric.

BLUEPRINTING—The fabric prints practically as fast as tracing cloth. The prints are clear and sharp, being quite as contrasty as ordinary blueprints. Being made from a white-on-black drawing, they show blue lines on a clear white ground. It is possible to make good white-on-blue prints from the first prints.

COST—The Unidraft Fabric costs "from 25 to 50% more than the combined cost of the drawing paper and the tracing cloth which it replaces." The makers intend to put it out regularly in sheets, on the idea that rolls are wasteful.

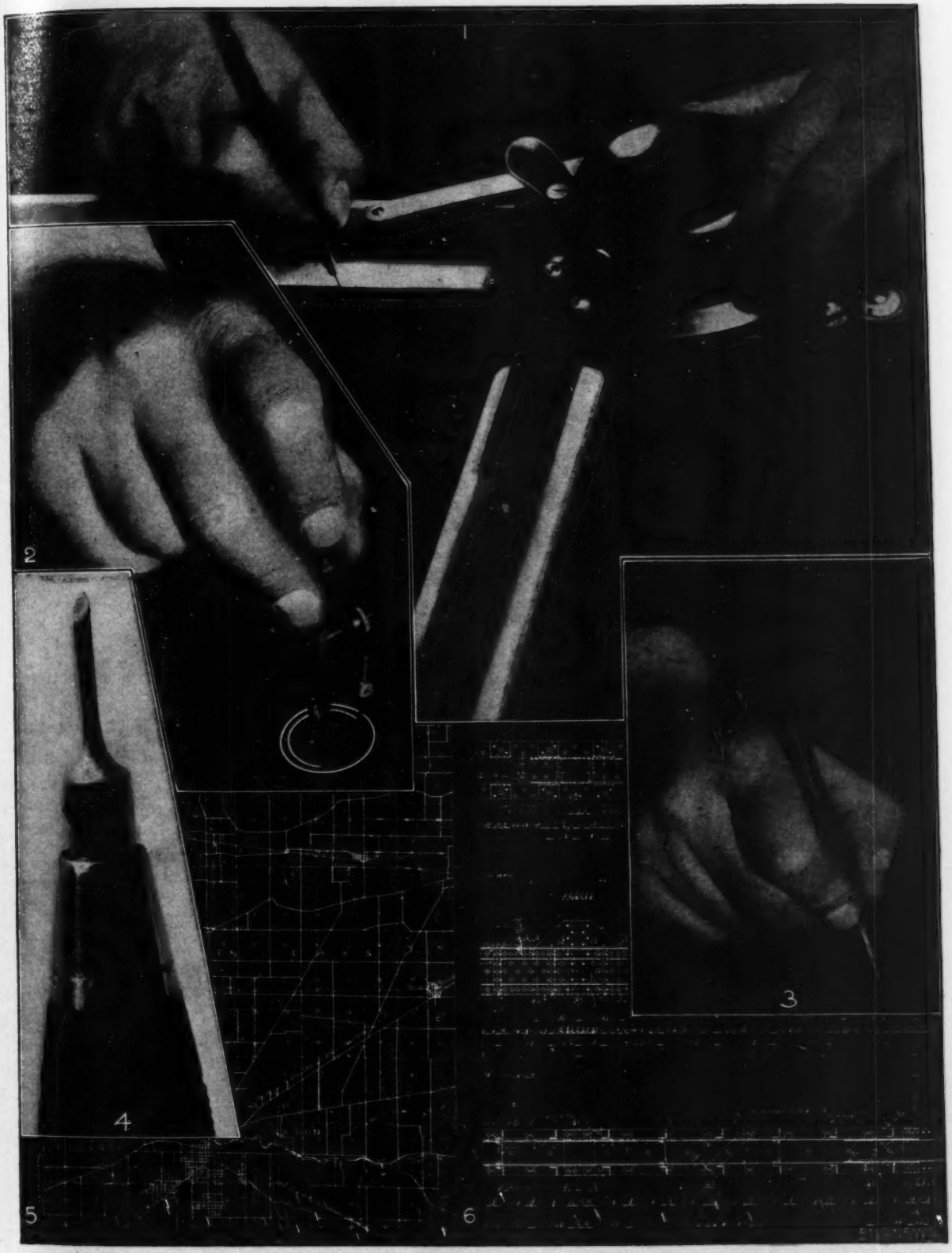


Fig. 1. Working on Unidraft Fabric with the drafting machine. Fig. 2. Scriber point in bow compasses for circle work. Fig. 3. Lettering; with a little practice the lettering becomes as perfect as ink or pencil lettering, and it is fully as rapid. Fig. 4. Scriber point for line work, magnified several times. Fig. 5. Part of a map drawn on the fabric, showing fine contours and heavier road lines, irregular lines, etc. Fig. 6. Part of a structural-steel drawing, with close line work of fine and heavy width, crowded lettering, and small bow-compass work. (Figs. 5 and 6 are reproduced direct from photographs of finished drawings on the fabric.)

THE NEW FABRIC AND SCRIBER FOR MAKING SINGLE-PROCESS DRAWINGS

A Very Large Block and Hook

Readers of current engineering literature have probably noted the gradual growth in six-sheave blocks during the past four years. The one here shown differs from that described in ENGINEERING NEWS of Jan. 5, 1911, in having ¾-in. instead of ½-in. plates. The block and hook illustrated are to be used on a 50-ton Mitchell derrick car manufactured by the American Equipment Co., for bridge erection.

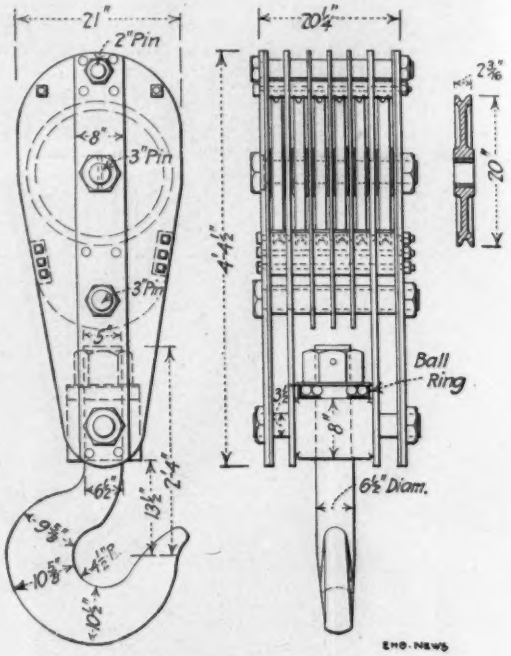
BIG SWIVEL HOOK FOR 50-TON PATTERSON BLOCK

The total weight of the block is 2500 lb. Its tail bolt is 2 in. in diameter; the sheave pin is 3 in. in diameter with a ½-in. dog to prevent turning. There are four heavy cast-iron separators between the ¾-in. plates. There are six sheaves, 20 in. in diameter, for ⅞-in. wire cables. The block is fitted with a ball-bearing hook, forged from an 8x 8-in. forging billet, flattened to 10⅝x 6½ in. The hook, with supporting beam, weighs 1040 lb.

The block was designed and built by the W. W. Patterson Co., Pittsburgh, Penn., for the Illinois Central R.R. It was delivered 23 days after the placing of the order.

Trench Backfilling Machine

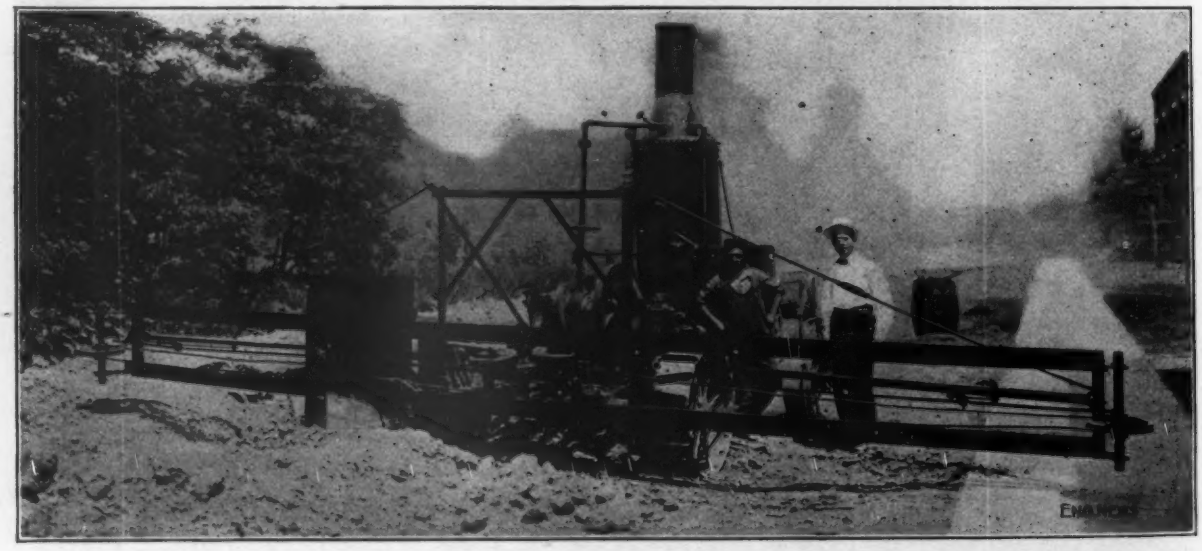
A backfilling machine for trench and other work is now being introduced, which travels at the side of the trench and scoops in the dirt from the dump pile left by the excavator. It has a 10-hp. hoisting engine and vertical



DETAILS OF LARGE HOOK BLOCK

boiler mounted on a steel frame carried by wide-tired traction wheels and propelled by its own power. It is about 10x10 ft. over the wheels.

Across the front of the machine extends a horizontal frame 16 to 40 ft. long, according to requirements, along which travels a carriage to which is attached a scraper plate. The carriage has wheels riding upon the frame



TRENCH-BACKFILLING MACHINE

(The scraper or bucket is attached to a carriage traveling on the horizontal frame and operated by a cable.)

and bearing against it laterally, the wheels having deep flanges so as to resist the vertical and horizontal thrust of the scraper. To the carriage are attached the ends of a wire cable which leads over horizontal sheaves at the ends of the frame, and then back over other guide sheaves on the front of the main frame, and thence to the engine drum. The scraper is L-shaped in plan, 24 in. wide and 36 in. high, and the carriage forms a back plate 36 in. long. It has an adjustable bottom plate or apron.

In operation, the machine travels near the side of the trench, and the scraper runs to and fro, scraping material from the dump pile into the trench. At each end of its travel the scraper strikes an adjustable trip, thus automatically reversing the engine. It makes 10 to 15 strokes per minute. The distance from the center of the trench to the center of the machine is equal to half the length of the long frame which carries the scraper. The machine has backfilled about 300 yd. in a single day, when working against a clay spoilbank that had stood for four or five months during the winter and had become hardened.

The machine is the invention of F. L. Monahan, of Joliet, Ill. It is intended particularly for use in connection with his trenching machine, and is a development of his earlier backfiller, in which a scraper was hauled by a cable from an engine on the opposite side of the trench, the scraper being run back by men handling and guiding it. This was described in our columns some time ago. The new machine is being built by William Heggie, of Joliet, Ill.

Cleaning Old Paving Brick by Compressed-Air Hammers

By Charles S. Butts*

The construction of the Rocky Branch joint district sewer at St. Louis, Mo.,† involved the disturbance of a considerable extent of paved street. The work is 5724 ft. long (on Blair, Palm and Glasgow Aves.) and was done by the James Black Masonry & Contracting Co., at a price of about $500,000.

Of the total length, 4600 ft. was in streets having brick paving grouted with cement, the paved width being 17 to 30 ft., and the total paved area being about 10,000 sq.yd., with about 530,000 brick. The specifications require the contractor to repave the streets and leave them in as good a condition as before the construction of the sewer.

The question was (and always has been) whether it pays to clean vitrified paving brick (cement grouted) for use in repaving streets. In cleaning them by hand a man can clean about 300 a day. And at $4.50 per 1000 (which was paid for this method of cleaning) he would only make $1.35 per day. In order to make it any inducement to clean them by hand about $9 per 1000 would have to be paid. The contractor finding this method not only slow but also unsatisfactory, abandoned the hand-cleaning method and adopted the following machine method which has proved very satisfactory.

An old vacuum-cleaning wagon was obtained and set up in a convenient location at the pile of brick to be cleaned and used as an air compressor. A ½-in. supply pipe was run to a cleaning board, and to it were connected ¼-in. hose, to each of which was attached a 6½-lb. stonemason's vibrating air hammer. The hammers had 1-in. chisel points for cleaning the portland-cement grout from the brick. A bench was built and about 70 bricks placed on it with the side upward. One side and one end were cleaned first; then they were turned and other side and other end were cleaned. As there was no cement on top or bottom it required only one turn to complete the cleaning. The capacity of this particular machine is three hammers, and, as the following table shows, the more hammers operated, the cheaper the brick can be cleaned.

	1 hammer	2 hammers	3 hammers
No. brick cleaned per day	1200	2400	3600
Cleaning brick, $2 per 1000	$2.40	$4.80	$7.20
Turning brick, $1 per 1000	1.20	2.40	3.60
Gasoline for machine	1.40	1.40	1.40
Cost	$5.00	$8.60	$12.20
5% for care of tools, etc.	0.25	0.43	0.61
Total cost	$5.25	$9.03	$12.81
Cost per 1000 brick	4.375	$3.762	$3.3558

The difference in cost per 1000 is due to the gasoline used, it costing $1.40 per day to run the machine whether

Cleaning Cement Grout from Paving Brick with Pneumatic Chisels at St. Louis, Mo.

one, two or three hammers are used. To the above costs per thousand for cleaning must be added about $2 for hauling to the pile and back on the street, which would make the cost (using the two-hammer price) $5.76 per 1000. This against $16 per 1000 for new brick makes a saving of $10.24 per 1000 for the small-size brick (2¾x4x8¼ in.). The large paving brick now in use (3¼x8½x4⅛ in.) would cost about $4.50 per 1000 to clean, plus $2 for hauling, making $6.50 per 1000 against $22 for new brick, a saving of $15.50 per 1000.

An Editor's Apology—The Secretary of the Oklahoma Society of Engineers prefaces Vol. 1 of the Society's "Transactions" with the following note:

Able contributors will be abashed to learn that their remarks have been garbled beyond recognition or omitted entirely. Many papers are missing and requests for brief synopses have generally brought no replies.

If the transactions are not worth perusing it must be the fault of the Society for entrusting the work to

THE SECRETARY.

*First Assistant Engineer, Sewer Department, St. Louis, Mo. (in charge of the construction of the Rocky Branch joint district sewer).

†"Engineering News," Apr. 16, 1914.

Rapid Excavation, Foundation of Citizens' National Bank, Los Angeles

The work of clearing up the site of the future 12-story Citizen's National Bank Building, at the northwest corner of Fifth & Spring St., Los Angeles, Calif., began on Apr. 28, but difficulty in acquiring certain buildings on the site prevented excavating going forward until June 8.

The lot fronts 115½ ft. on Spring St. and is 155 ft. deep. There will be eight cantilever footings, each containing 2000 cu.ft. of concrete and 4 tons of steel reinforcement, with bottom of cantilever 40 ft. below the sidewalk. Forty piers with pedestals are to be placed, averaging 20 cu.yd. of concrete and 1500 lb. of steel each. A sub-basement with floor 30 ft. below the sidewalk occupies an L-shaped portion of the lot adjoining the north and west property lines. The remaining portion of the building will have a basement with floor 13 ft. below sidewalk.

When once started, the excavating was pushed rapidly, and was completed in about one month.

Excavation was started by a steel stiff-leg derrick, of ... ft. boom, using buckets of 2-cu.yd. capacity, shown ... Fig. 2. The deep excavation necessitated a comparat... ly long boom, but made its operation difficult on ... count of the limited space. The buckets were loaded ... hand, lifted by the derrick and dumped into a 30-cu.y... bunker placed 12 ft. above the sidewalk at Spring St. The earth was removed from the bunker by motor truc..., which carried it about two miles, requiring 30 minut... for the round trip. The derrick could take out 500 cu.yd. in 24 hr.

Old brick walls abutting the site were shored and underpinned. At the left of Fig. 1 is shown a two-story brick wall, which extends about 8 ft. below the sidewalk. This wall was carried down in some places to a depth of 40 ft. The underpinning required the use of 300,000 bricks.

Fig. 3 shows the retaining-wall necessitated by an alley on the west. This retaining-wall was of reinforced concrete, 40 ft. high, 3 ft. thick, with a reinforced footing 8 ft. wide. The wall was heavily shored during construction.

All the buildings on the site had been removed by June

FIG. 1. SITE SHORTLY AFTER START OF WORK

FIG. 2. SHOVELING INTO DERRICK BUCKETS

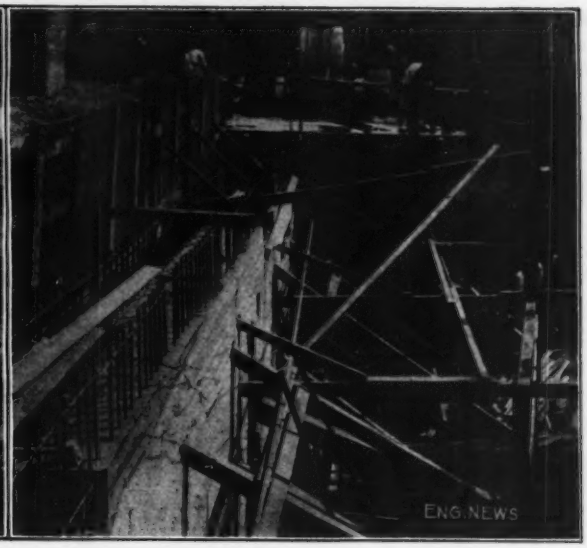


FIG. 3. CONCRETE RETAINING-WALL WITH TIMBER SHORING

12, when teams were put to work on the shallow portion. The derrick continued in service until the night of June 14, when a cable broke. As the deep excavation was practically completed at this time, the derrick was removed and the work finished by teams. A wagon of 1½-cu.yd. capacity was loaded in 8 min. by 21 shovelers (mostly Mexicans), and hauled to the street in 2 min., with the assistance of two snatch teams. The work was scheduled for completion July 1, and will actually be completed shortly afterward. Extension of time was necessary and allowed, on account of delays caused by conditions beyond the control of the contractor.

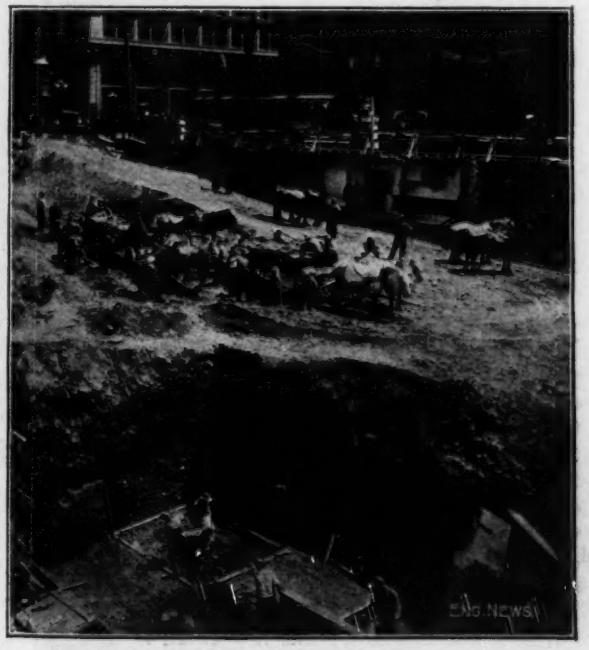


FIG. 4. EXCAVATING WITH TEAMS ON SHALLOW PORTION

The excavation amounted to 15,000 cu.yd.; while 3000 cu.yd. of concrete and 70 tons of steel reinforcement were placed. Fig. 4 shows progress on the foundation and excavation up to June 29, and the firm character of the soil.

The work has been pushed night and day, and according to the engineer would have been completed two weeks earlier had the lot been clear of buildings at the start. After all the leases were purchased, the last three buildings were wrecked in 24 hr.

The excavating was done by the Sound Construction & Engineering Co., Seattle, Wash., whose engineer in charge is J. T. Walsh.

Sub-Irrigation and Drainage for Golf Greens

To keep the golf greens of the parks in good condition during the summer, the Park Department of St. Louis has constructed them with a sub-irrigation system, supplemented with a drainage system for the removal of excess water.

Along one end of the green is laid a 1-in. iron header

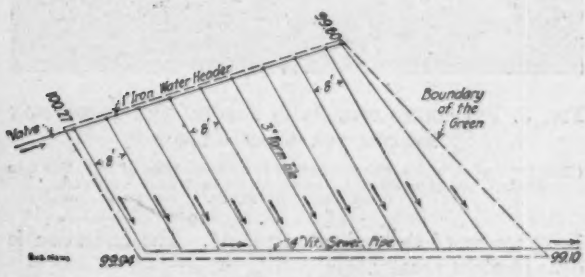


FIG. 1. PLAN OF GOLF GREEN, WITH SUB-IRRIGATION AND DRAINAGE SYSTEM; PARK DEPARTMENT, ST. LOUIS, MO.

pipe, with 4-in. branches of ⅜-in. brass pipe inserted at intervals of 8 ft. Each branch ends in an elbow, turned downward, and enters the upper end of a line of 3-in. farm drain tile laid with open joints and having a slope of about 0.5%. These lines of tile connect with a 4-in. vitrified sewer pipe laid along the opposite side of the green, this pipe extending to a sewer connection. The 3-in. tiles are laid in a 5-in. bed of sand above, which is 12 in. of soil, and the grass roots run down to the bed of damp sand and get an ample supply of moisture.

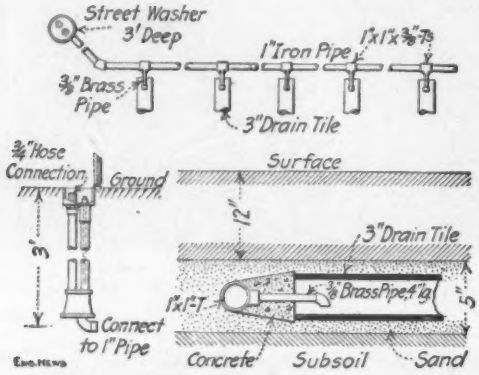


FIG. 2. DETAILS OF SUB-IRRIGATION FOR GOLF GREENS

The water is supplied by a 1-in. pipe laid 3 ft. deep and connecting with a McNamara street washer which serves as a valve box. From the top of the riser pipe of the street washer a ¾-in. hose connection is made to the

FIG. 3. PREPARING THE SAND BED OF THE IRRIGATION SYSTEM FOR GOLF GREENS

(The iron pipe has a short branch into each line of tile, the tile drains being bedded in sand and the whole covered with 12 in. of earth.

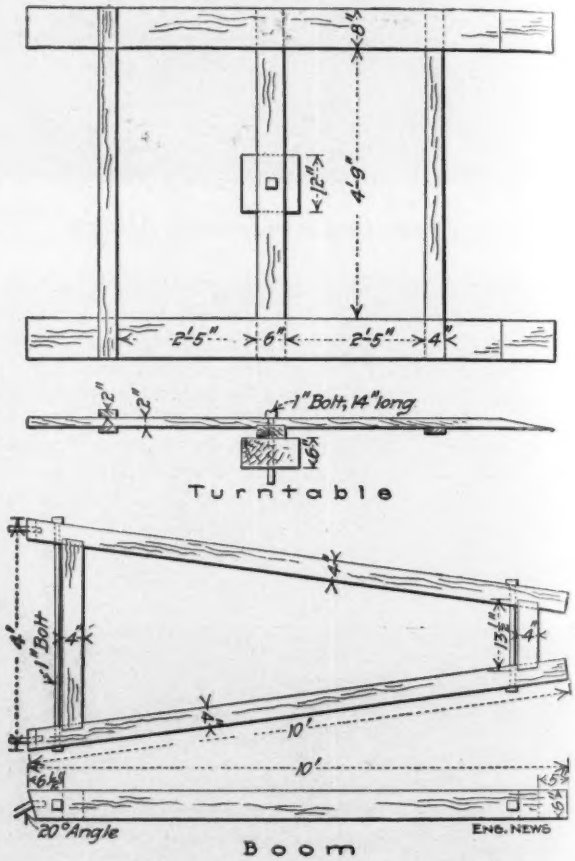
1-in. header of the irrigation piping. The irrigation is done at night usually.

A number of greens have been equipped with this system. It was designed by Nelson Cunliff, Superintendent of Construction of the Park Department, and the work has been done by the park forces under his direction.

A Bridge Repair Derrick

A truck derrick for bridge repair and maintenance designed by H. Walker, master carpenter of the Cincinnati, Lebanon & Northern Ry., is illustrated by the accompanying drawings. The derrick consists of a truck carrying a platform upon which is a small windlass and boom, with blocks and tackle. Its object is to facilitate the handling and renewal of stringers, and other heavy timbers in the maintenance of wooden bridges.

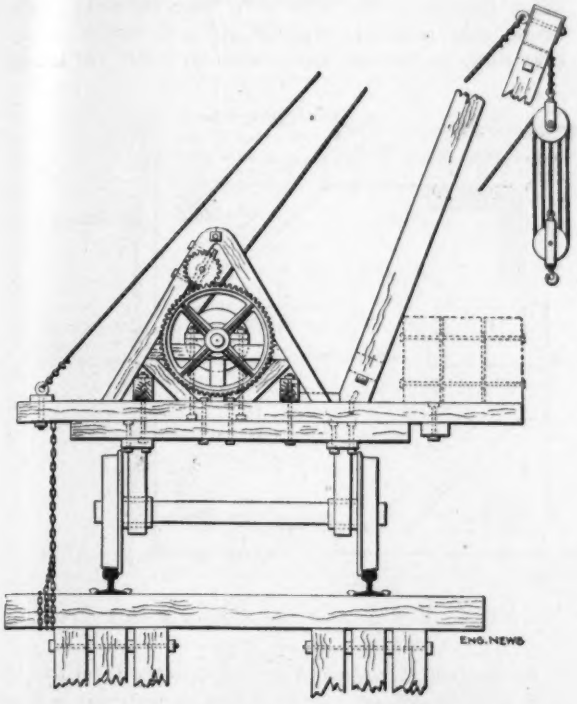
Edmund Feldman, 3591 Wilson Ave., Cincinnati, Ohio, who sends us this information, states that with this tool four men can handle and replace a 16-ft., 3-ply chord



DETAILS OF BOOM AND TURNTABLE OF THE TRUCK DERRICK

in a half-hour. To perform this operation, the wood guard rail above the chord is first removed and the bolts connecting the chord to the corbels are taken out. The track rail is then jacked up about 6 in., carrying the ties with it, which gives free access to the stringers. The truck derrick is run over the bridge to about the center of the stringers to be removed, and chained down to prevent tipping during lifting. A chain is placed around the chord which is then hoisted and placed on the truck in the location provided for that purpose. The truck is then unchained and pushed off the bridge where the stringers are unloaded. The new chord is then picked up by means of the derrick, pushed onto the bridge, and lowered into position. The bolts and guard rail are then

replaced. A turntable is provided so that the truck can be used on the other side of the bridge without dismantling the derrick.



ELEVATION OF A TRUCK DERRICK FOR BRIDGE REPAIR

The derrick was built by Mr. Walker for his particular needs and is not manufactured commercially.

Expensive Repairs to an 8-In. Water Main, 40 Ft. under Water*

About two years ago, an 8-in. cast-iron water main was laid across Galveston Channel, from a connection with the city water mains of Galveston, Tex., to the Government Immigration Station, on the north side of the channel, 1400 ft. distant. The submarine portion of the main was laid in a trench 40 to 100 ft. wide, dredged to a depth of 41 ft. across the entire width of channel, which was then 30 ft. and less in depth. The main was constructed with flexible joints of the ordinary ball-and-socket type, which allows deviation from a straight line of about 12°. Ordinary lead calking was used with yarn packing.

Soon after the pipe line was completed and water turned into the main, leaks began to develop, due partly to the method of laying and to the uneven character of the bottom, which caused such a deflection at each joint that the lead calking squeezed out. Other damage was done to the pipe line by a ship's anchor before the pipe laying had been completed. Efforts made to recalk the leaky joints by the aid of a diver were unsuccessful, because the pipe was found deflected to such an extent that there was no room for calking on two sides of the joint.

BOX FORMS FOR INCLOSING LEAKY JOINTS

The method adopted for repairing the leaks was as follows: A wooden box form was placed around each joint, and this form filled with neat portland-cement grout. Each form was supported on three 3-in. pipes, 14 ft. long, driven through holes in the box forms into the underlying clay, so as to form a pile foundation and prevent settlement at the joint.

The box form is shown in detail in the accompanying sketches, Figs. 1, 2 and 3. The box was hinged along one horizontal top edge and opened diagonally. In the top is a 4-in. hole with a pipe flange for connecting a 4-in. pipe extending to the top of the water, as shown in Fig. 3, through which the grout was poured into the box from a barge above.

A chain, fastened to one side of the lower half of the box, helped to close it and held it closed; one link was looped over a hook attached to the upper half of the box, and the hook was screwed up until the form closed tight. On opposite sides of the box, where the water pipe passed through, square holes 18x18 in. were left in order that the box form would close, no matter if the adjoining pipes were at their greatest possible angle, either vertical or horizontal.

Movable diaphragms, each consisting of two pieces, 2x12 in. by 3 ft., with holes cut in the form of an 8-in. semicircle to take one-half the pipe, closed around the pipe, tightly covering it and at the same time entirely closing the 18-in. holes. These false ends or diaphragms were outside of the form and were held in position by iron straps, under which they could move freely against the side of the form.

Three holes, large enough to take a 3-in. pipe, were bored through the top and bottom of the form for the piling. After the pipe piles were driven down through the form flush with its top, ½-in. iron plates were laid over the tops of the piles and bolted to the form, to carry its weight until the cement grout had set around the piles.

CONSTRUCTION METHODS

Most of the filling over the water pipe was removed by a 20-in. suction dredge, but for fear of disturbing the pipe, work with the dredge was not carried within 4 ft. of the top of the pipe. The rest of the fill was removed by an 8-in. sand pump, mounted on one of the barges. After dredging, the water was cut off from the main, and air pressure was put on, and the leaks were thus located by air bubbles coming to the surface of the water.

All leaks of any consequence were marked by dropping a weight into the hole blown through the mud over a leak by the escaping air, and carrying a line ashore from the weight. It was not safe to use buoys for marking the leaks, as a buoy was liable to be carried away by ships. All leaks had to be located and marked before repairs were commenced.

After the box form was placed the air pressure had to be taken off the line and kept off until the cement grout in the box form was thoroughly set.

*Abstract of article in "Professional Memoirs," Corps of Engineers and Engineer Department at Large, July-August, 1914, pp. 553-559, by N. T. Blackburn, Junior Engineer, Galveston, Tex.

The construction plant consisted of two barges, one carrying a derrick, and the other an 8-in. belt-driven sand pump. The barges were anchored over the leak, and the overlying sand and mud covering was first pumped away. Then to the flange coupling on the box form was connected a 45-ft. length of 4-in. pipe. Three rope lines were fastened to the front of the lower jaw

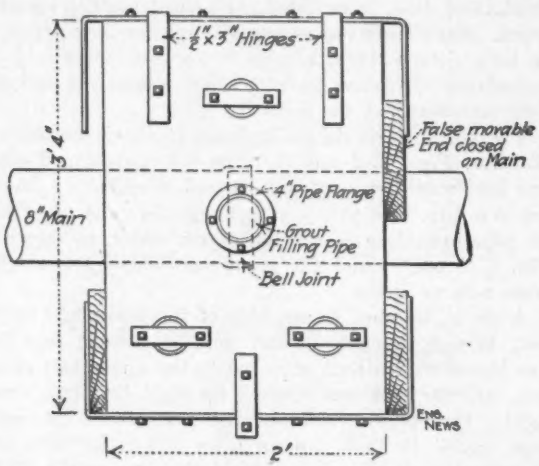


FIG. 1. PLAN OF BOX FORM FOR REPAIRING LEAKY JOINTS

of the form, one to the end of the closing chain, and one near each side.

The driver took all three lines down around under the pipe and back up on the barge, where a man was stationed at each line. As the form was lowered away by the derrick with a line from the 4-in. pipe, the men took in on the other three lines. The form was thus guided into place under the pipe. Lowering on the upper half the form closed the box in position.

The piles were then driven flush with the top and the iron straps bolted over them. A water jet was inserted in the box form through the 18-in. square openings, and any mud in the box was driven out and the pipe joint thoroughly washed clean. A piece of raveled, loose rope yarn was tied securely around the leak to keep the cement from entering the pipe joint. The plank diaphragms were then driven into place around the pipe, and the form was ready for the grout.

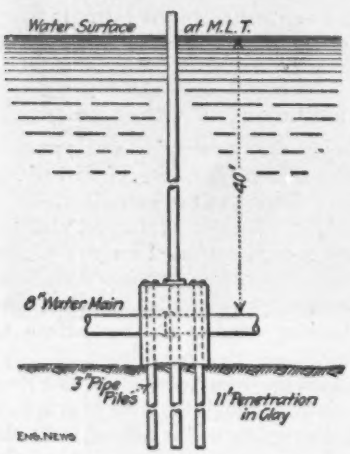


FIG. 3. BOX FORM IN PLACE FOR GROUTING

The grout was mixed with salt water to a consistency that would just pour through the funnel into the 4-in. pipe leading down to the form. It was found necessary to pour it slowly in order to give the grout time to settle. Displaced water went out of the form through the holes around the piling in the top of the form. When the form was filled, the nuts on the bolts in the flange union fastened to the form were taken off and the 4-in. filling pipe removed; and the job was completed. To save time, on the last joint repaired, grout was lowered

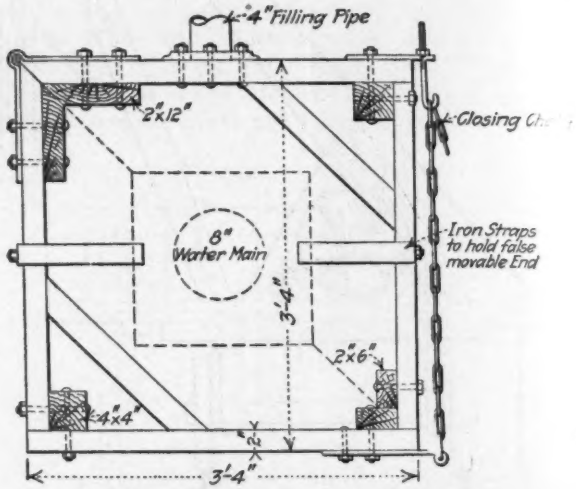


FIG. 2. END ELEVATION THROUGH BOX FORM

to the diver in buckets and poured into the form by him.

Where the soft mud and silt was so bad that it could not be kept out of the form, a 4-in. centrifugal pump with a flexible suction end was to clean out the box, after it was in place and closed. The mud was pumped out through the grout filling hole, while a jet alongside stirred it up.

When repairs were completed, the grout was allowed to set a week. About 40 lb. air pressure was then put on the main and kept on for over an hour. During this time only a single air bubble could be seen, and the water meter on the main showed the leaks had been stopped.

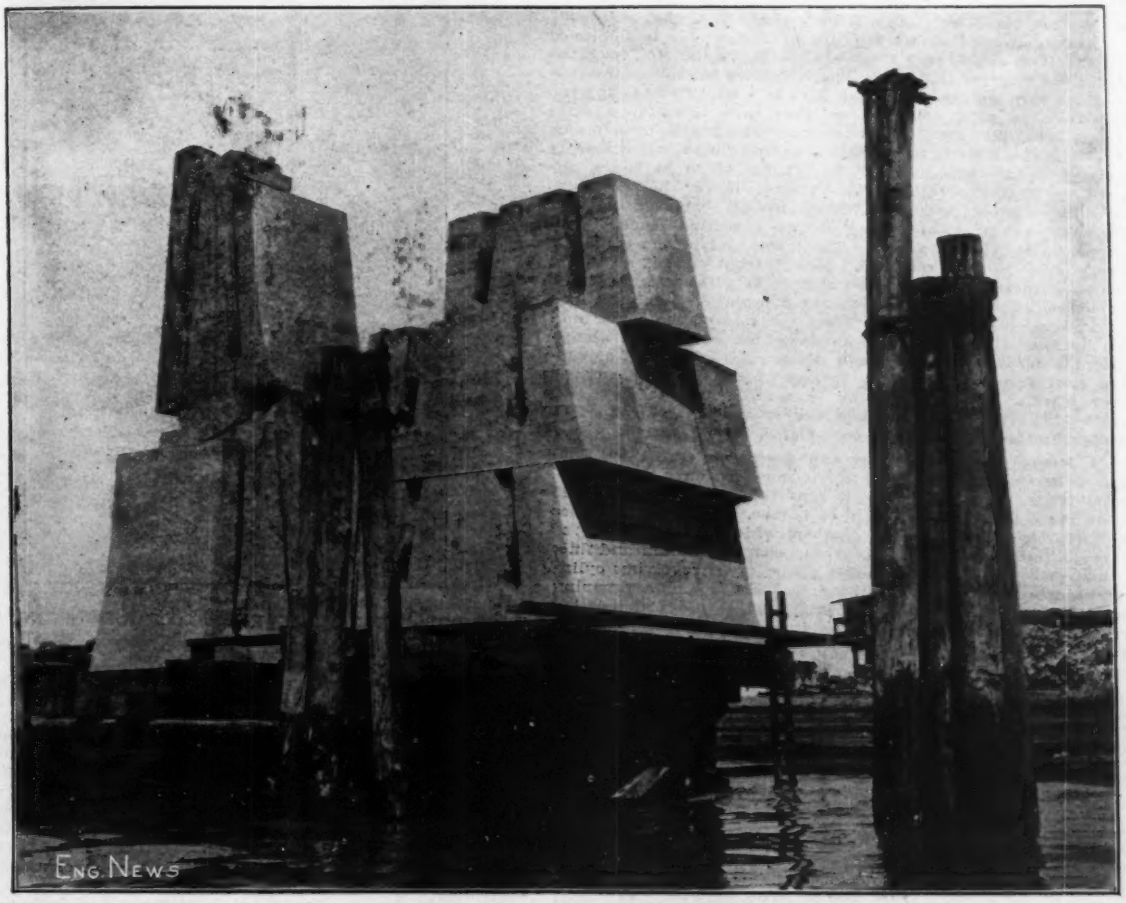
Four leaks were repaired and the entire work was executed in about four weeks, including the time of assembling plant, dredging, building box forms, etc. By actual time a box form was lowered and fastened around the pipe in 45 min. To close the end diaphragms of the box form required 50 min. To drive the piles required from 1 to 1½ hr. To mix the grout and fill the form required 1 hr. and 15 min. A good deal of credit was due the diver for the rapidity with which the form was placed. The diver worked without a suit, but simply had a diving helmet over his head. With the proper plant after the water main was cleared, one leak a day could be repaired.

COST DATA

The total cost of repair work, for closing the four leaks, was $2300. The work was done by the United States Engineer Department, under the direction of Lieut.-Col. C. S. Riche, Corps of Engineers, and the plan of closing leaks was devised, designed, and superintended by O. R. Scott, U. S. Inspector. The force consisted of one foreman, one hoisting engineer, six laborers and one driver.

NOTES

A Remarkable Pile Test—The accompanying view shows a test of a group of piles under a load of 220 tons now being carried on by the Department of Docks & Ferries of New York City, under the direction of Chief Engineer Chas. W. Staniford, in the construction of the 46th St. pier of the North River, in the Borough of Manhattan, a description of which appears on p. 212 of this issue. A portion of the pier is to be built in deep water on timber pile footings, which on account of the heavy silt and mud bottom have to be nearly 90 ft. in length. The design calls for carrying the pier proper on 10-ft. spaced piles, but the shed and upper works are to be carried on 20-ft. spacings of columns, footing on pile clusters. This wide spacing requires that each cluster shall have a loading of about 220 tons. The test shown herewith is the second one of two which have been carried on by the department to determine the bearing power of the long pile clusters driven in deep water and very soft mud bottom.



A Remarkable Pile Test

Each cluster consisted of a square of 16 piles, in the first test the piles being driven on about 2-ft. 6-in. centers, and in the second on about 3-ft. 6-in. centers. Each pile is of Eastern pine and is between 85 and 90 ft. long. In the first test, every other pile was lagged on the sides with a double lagging of four 5x6-in. timbers for a distance of 30 ft. up from the bottom of the pile. These four timbers are spaced around the four quarters of the pile circumference and are bolted through, two and two. In the second test every pile in the cluster was lagged.

A marked and continuous settlement was noted in the original test, which has been in progress about seven months, but in the second test, which has been in progress about four months, satisfactory results have so far been obtained under the loading of about 220 tons. It will be some time before the full details of the test are available.

The concrete blocks which are used to load the cluster are the regular quay-wall blocks used by the Department of Docks and Ferries in the construction of the bulkhead walls around New York City. They were floated up to the site and loaded on the structure with the department's 100-ton barge crane. They are to be used in the permanent wall somewhere, when the experiment is finished.

Repairing a Dredge Hull Below the Water Line by Use of an Ice Coffer-dam—The United States dredge "Warroad" was repaired at Kenora, Ont. (Lake of Woods), in 1912 as follows: When the ice had formed about the dredge to a depth of 18 in. a trench was made 20 ft. long, 3 ft. wide and 12 in. deep alongside the dredge. Thereafter each day, when the thermometer had been below zero the night before, 1 in. of ice was cut out of the bottom of the excavation. Days when the thermometer was not higher than +15° F. during the entire day, there were taken out 1½ in. After each day's work a small hole was bored to a depth of 5 in. and dry wooden plugs kept near to plug the holes in case the bit broke through, but it never did. The rate of cutting and the means of insuring a thickness of 5 in. in the bottom of the trench were determined by the custodian of the dredge, as he had no instructions except to get down to the leak. It is probable that he might have gone down somewhat more rapidly, but he was present every day in care of the dredge and there was no occasion to hurry. Parties harvesting ice at that time found that their ponds, left open at night, were frozen about 2 in. during the coldest nights. During the operation, the maximum daily temperatures ranged from +30° to —15° and the minimum from +6° to —47°. Only once was the minimum above zero, and the maximum was below zero for five consecutive days. On Feb. 24—in exactly 30 days—there was a trench 20 ft. long, 3 ft. wide, and 34 in. deep, with 6 in. of ice in the bottom. The thickness of ice in the vicinity was 24 in. So we had gone down 10 in. below the bottom of normal ice; we still had 6 in. under us; and had uncovered the leak 34 in. below water line. The repairs amounted to nothing more than cleaning out a small split

in a plank and caulking it. [Lieut.-Col. Chas. L. Potter, Corps of Engineers, U. S. A., in "An Ice Coffer-dam," Professional Memoirs, Corps of Engineers, U. S. A., May-June, 1914, p. 439.]

Computation of Lot Lines on Curved Streets—A. M. Haynes, of 314 So. Washington St., Denver, Colo., is worried lest the method of computing lot lines described by P. H. Skinner in "Engineering News" of June 25, p. 1241, will mislead surveyors. He writes to Mr. Skinner as follows.

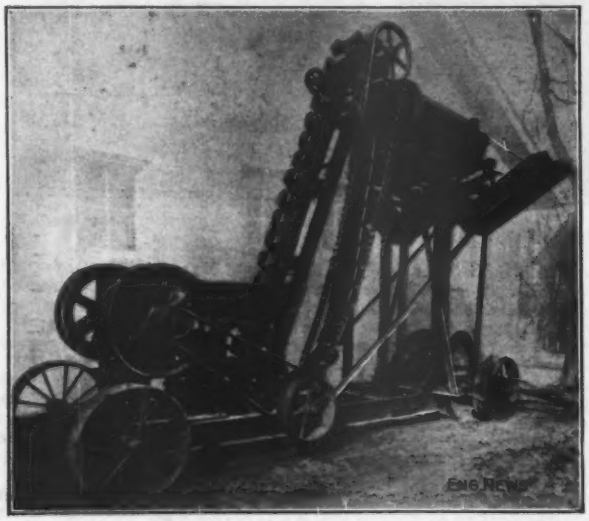
I have been to much trouble making tables for the work you describe. It is the same method as invented by Shunk and copied by many authors in the past 30 years. I made a new definition for Degree of Curve and made the work exact. I find the degree of your curve is 11.475°. Your x is half the long chord, and y is R — versed sin of double your angle A. My tables give exactly the same figures that you have for frontage, and I do not bother with the old-fashioned Sin, Cos, etc. Should you not send this to the "Engineering News" to repair damages? A lot of poor transmitmen will lose their jobs trying to follow you.

To this letter Mr. Skinner replies as follows:

To cover the remote possibility that others may have fallen into the same misapprehension that has brought forth the letter from Mr. Haynes, it may be said that the method of computing curves, described in "Engineering News" of June 25, is intended for use only where logs or a calculating machine are available. Such an arrangement of work has been found to shorten the computations greatly in the office, but no claims are made for it as a field method.

A Wagon-Loading Machine for dry brick clay is employed by the Hydraulic-Press Brick Co., of St. Louis, Mo., in gathering the clay for its plant. Special plows hauled by traction engines turn up the top of the field to a depth of 1½ in., the teeth of the plow being so set that each turns up a strip about 4x1½ in. This strip curls over and breaks into pieces 4 to 8 in. long as it falls from the plow. The entire field is plowed in this way and left to dry for 12 to 24 hours, according to the weather. The wagon loader has a four-wheeled wagon bed, surmounted by an enclosed vertical frame or tower within which works a vertical bucket conveyor, having long buckets. The lower end of the conveyor comes close to the ground and just in front of it is an apron which gathers up the clay so that it is within reach of the buckets. At the top, the buckets dump their contents into an inclined chute projecting from the side of the tower and discharging the clay into wagons which are driven alongside the machine as it travels across the field. The elevating conveyor is driven by a sprocket chain from one of the rear wheels, and the machine is hauled by a team of six mules. The plows and wagon loaders are of the company's design and are built in its own shops.

A Dinkey Stone-Crushing and Screening Outfit is illustrated herewith. The whole plant mounted on a four-wheel steel truck weighs only about four tons and can be moved from place to place by a pair of horses. The outfit includes a Fort Wayne No. F-2 jaw crusher, which has provision for three different toggles, for crushing coarse, medium and fine; a belt-driven steel chain bucket conveyor; a revolving cylindrical screen, with dust jackets if desired; and a dumping or loading chute. The jaw opening for coarse and medium crushing is 8x12 in. and for fine crushing 5x12 in. The elevator is 12 ft. 6 in. long. The revolving screen is about 3 ft. long and 2 ft. 6 in. in diameter. The mounting is a steel frame of I-beam construction with heavy steel wheels and axles. The wheels have broad tires, and the hubs are provided with lubricating cups. Motive power for operating the crusher, elevator and screen may be furnished by an 8-hp. gasoline engine, which, however, is not part of the outfit as shown. The speed of the eccentric shaft is designed to be 285 r.p.m. and the belt drive should be 16 to 18 ft. long. The outfit described is made by the Good Roads Machinery Co., Kennett Square, Penn.



A Small Portable Crushing and Screening Plant

Nailed Wedge-Shoes for Shores in Floor Centering—Placing concrete centering accurately and economically is an engineering problem. Floor centering, when ready for concrete, should be level, and the accompanying illustration shows how Wells Bros., Chicago contractors, start to get level points before placing shores for floor centering.

On the finished concrete surface of the floor over which they are working, and which is brought to a true surface with the top finished, 1-in. boards are laid, on which are

Setting Wedge-Shoes for Floor Centering to a Uniform Elevation with Level and Rod

placed wedges, cut from ordinary 2x4-in. stuff, to serve as shoes for the vertical shores.

To establish levels for each panel a handy man goes ahead with wedges, and at four well distributed points for each panel he nails in place the bottom half of a pair of ordinary 2x4 wedges, fastening it firmly to the 1-in. sills. A wye-level is set up at a convenient point on the floor, and a definite uniform elevation is established by adjusting the pairs of wedges to a known level established by the instrument. Then the top half of the wedge is nailed in place, determining accurately at 4 points in each panel a standard elevation.

New Types of Automatic Water-Stage Registers have been put on the market by W. & L. E. Gurley, Troy, N. Y. These include an entirely new device which makes a printed record of the water height at intervals of 15 or 30 min. This register is built and installed like the regulation gage-curve recording registers, but instead of a pen point moving over a wide roll of paper, a narrow ribbon of paper passes continuously under a time stamp. The type wheels for printing the height records are moved automatically by the rise and fall of the copper float in the gage well. The motive power for operating the register is a weight-driven clock, the weight of which descends ot the rate of 1½ in. in 24 hr. The ribbon record is 1¼ in. wide, and the record for 24 hr. is 96 impressions within a space of 2 ft. The range of the machine is 36.99 ft.

The same manufacturers have also improved their standard graphic registers so that they will make two and seven-day records, of the curve kind.

Editorials

Lessons from the Lowell Experiments on Well-Water Treatment

The experiments on driven-well waters at Lowell, Mass., described in our issue of July 9 and in our present issue, are encouraging not only for Lowell but for other cities as well. At the same time they illustrate anew the difficulties that may be encountered with well waters, even where such supplies do not seriously diminish in quantity as well as in quality after a few years' use. They also show how each well water may be a law to itself as regards needed methods of treatment.

Twenty years ago Lowell began to secure a water-supply from driven wells. The water from the first wells sunk appeared at first to be satisfactory in quality, but not being sufficient in quantity, more wells were sunk at a different site. After a few years' use, it was shown that an excessive amount of carbonic acid in the water from the first wells attacked lead service pipes and caused lead poisoning throughout the city. The other wells were therefore added to and the first wells abandoned, except for summer-peak use. Although several extensions to the new well system were made, the water from it gave more and more trouble from turbidity and color. This was at first attributed wholly to iron in the water, but it has been shown recently that the trouble was due to manganese as well as iron.

Hygienically, the Lowell well water was excellent, as indicated by the typhoid record. It was therefore decided to find out whether the iron and manganese could be removed from the one well system and the carbonic acid from the other.

The experiments emphasize afresh that each well water is a law unto itself when it comes to removing or neutralizing unsatisfactory mineral contents, and that a testing or experimental plant, in the hands of trained men, is often needed to find the law and the best means of applying it in daily practice.

So far as iron is concerned, some of the many conditions governing its removal are thus stated in F. A. Barbour's report on his recent Lowell studies:

> Iron, which is found in the form of ferrous hydrate, can be readily oxidized, and if there are no interfering substances, such as manganese, carbon dioxide, or organic matter, which hold the iron in semisolution, or in a colloidal condition, it can be precipitated and removed by aëration and sand filters. In some waters, however, excessive aëration is possible, and a retention of a certain portion of the carbon dioxide is necessary to prevent the organic matter from interfering with the precipitation of the iron. Also, it has been found that manganese interferes, and the removal of the last traces of iron, if the necessary conditions are not provided for the coincident removal of the manganese is impossible. It therefore follows that, while the deferrization of some waters involves simple aëration and sand filtration, others require more highly developed preliminary treatment by passage through coarse filters, operating either as tricklers or contact beds.

Apropos of the last clause of the last sentence, it may be noted that coke prefilters at Lowell, it was found, should be operated as contact beds rather than as trickling filters for the removal of iron and manganese.

The diversity of well waters from sources near together is illustrated by Lowell experiences. One series of wells yields water high in iron and manganese and another gives a water low in iron but with so much carbonic acid that the water attacks metal service pipes. Close by the group of wells last mentioned, with low iron content, is a third group, for some time unused, with an iron content so high as to promise trouble with the increase of iron that so often follows use.

Considering now the removal of carbonic acid from the Lowell wells, it is worthy of note that before the experiments were begun, it was supposed that a fraction of a grain of lime per gallon of water would decarbonate this water. Instead, it was found that 1½ grains per gal. would be required, which would have added an intolerable hardness to the water. Fortunately, the experiments showed, the carbonic acid can be easily removed from this water by aëration by means of fine-spray nozzles under light pressure.

As we said at the start, the Lowell experiments are encouraging to all who have certain ground-water problems to solve. But it must not be overlooked, as we have tried to make clear, that each ground water is so much a law unto itself as to make it unwise to adopt any special mode of treatment until local experiments, or at least expert advice based on laboratory tests, indicate that the proposed treatment will successfully and most economically meet the conditions of that particular water.

Legislating the Massachusetts State Board of Health out of Office

Whether considered as a sacrifice to politics or to progress, the abolition of the time-honored and justly renowned State Board of Health of Massachusetts will come as a shock to sanitarians and public-health workers the world over. We sincerely hope that the State Department of Health which takes the place of the Board will make as enviable a record for itself and do as much for public health and sanitary progress within and outside of Massachusetts as did the State Board of Health.

Unfortunately, the new Department starts with a handicap—or a bunch of handicaps. First of all, the Governor and his political associates are under suspicion of having successfully promoted a reorganization of the health administration of the State in the name of governmental progress but with political expediency as the real object. This suspicion may be lived down by a judicious series of appointments to the positions of Commissioner of Health, Public Health Councillors, Directors of Divisions and District Health Officers. But even if this suspicion be lived down instead of being justified by the building up of a part of a state political machine, the fact will remain that the new Department of Health of Massachusetts will be of a mongrel administrative type.

The Commissioner of Health, nominally the chief exe-

cutive health officer of Massachusetts, is really under the control of the Governor and Council of the State on the one hand, since they confirm all appointments made by the Commissioner, while on the other hand, he is dependent on the Public Health Council (1) for the approval of the appointment of directors of divisions and of district health officers before these appointments go to the Governor and Council (a sort of State Cabinet) for confirmation; and (2) is also dependent upon the Public Health Council for the enactment of department rules and regulations. In addition, the Public Health Council acts as a Board of Appeal, presumably from orders issued by the Commissioner, although that is not clear. The Commissioner reports to the Public Health Council and the latter to the Legislature, through the Council.

Instead of an out-and-out single-headed Department of Health, Massachusetts will have a combination of the commissioner and the board plan, with neither supreme, and with Commissioner, Public Health Council, Directors of Divisions and the eight (geographical) District Health Officers all creatures of the Governor.

To make matters worse, the members of the Public Health Council are to be paid $10 a day and traveling expenses, which is just enough to attract place-seekers but too little to compensate men of training and ability, who would rather serve gratuitously than be paid inadequately for their time.

The long and short of the matter is that what was heralded at the outset as a radical reorganization of the state health service of Massachusetts, with a single independent Commissioner, quick and powerful in action, turns out to be little but the substitution of a Council for a Board and a Commissioner for a secretary, with neither in supreme command, and with a nebulous area of duties, powers and relationships in place of sharply delimited fields of responsibility and power.

Whether the old board plan or the newer single-commissioner plan is the best for Massachusetts or for any other State, we are not discussing. That a jumble of the two should be avoided seems to need no argument.

We are not so rash as to say that even under the abortive act which goes into effect on Aug. 7 (see our issue of July 16), men of training, ability and devotion cannot sustain the high standards of the Massachusetts State Board of Health which so many of us have long admired and rejoiced to honor. Men like Mills and Walcott, Woolcott and Harrington, Stearns and Noyes, Drown and Sedgwick, Hazen and Fuller, to name only some of the former members, secretaries, engineers, chemists and biologists who have helped make the Board known the world over, would rise above any petty obstacles incident to a badly messed piece of legislation. But, and there's the rub, they would not stoop to become parties to the political expediencies which the present act seems on its face to have been drafted or deformed to serve.

If the new appointments are not already made before these words are printed, a few weeks at most will serve to show in large measure how far the Governor of Massachusetts, in advocating a reorganization of the State health service, was actuated by a desire to give the State what he conceives to be a more efficient health administration and how far his ruling motive was to build up a more efficient political machine. If, as we hope, the health service is the thing at heart, able men can doubtless be found to carry on the work so well performed in the past and the next legislature can perhaps be induced to remedy the obvious defects in the new health act, as well as the weaknesses which a few months will bring into prominence.

A National Water Law

The need of national legislation on the matter of river regulation and control is agreed upon by everyone familiar with the facts. That, however, is about the only point on which agreement exists. One group is concentrating all its energies to have a national law passed that will facilitate the development of unused water powers by private enterprise. Another group is concentrating all its influence to secure the enactment of legislation under which the federal treasury can be tapped to aid in the construction of levees for the Mississippi and its tributaries. Still another group is infatuated with the idea that the Newlands bill, with its fantastic plan for concentrating all authority over the uses of water for every purpose throughout the length and breadth of the United States in a federal bureau at Washington, is the way to salvation and is working diligently for the success of that scheme.

It may be freely admitted that many of the advocates of the Newlands scheme are actuated by high ideals; but as we showed in an analysis of the Newlands bill in these columns a year or so ago, the Newlands bill as a measure of practical government administration is far too vast and unwieldy and complicated to possibly be successful.

The trouble with all these schemes heretofore presented is that they have been drafted to serve some particular interest and generally with entire ignorance of the other interests involved. Under these circumstances, the work of the special committee of the American Society of Civil Engineers appointed to prepare a national water law with special reference to the Federal control of interstate waters is particularly timely. This committee has just sent out a circular letter of inquiry asking for information where controversies exist over the use of interstate waters, and its aim evidently is to obtain first of all a large amount of facts on which to base its general conclusions. Any engineer desiring to aid the committee in this work by giving information as to controversies in which the control of interstate waters is involved can doubtless obtain copies of the circular letter of inquiry by addressing the Chairman of the Committee, Frederick H. Newell, Chief of the U. S. Reclamation Service, Washington, D. C.

Cellular Sheet-Pile Coffer-Dams; The Maine Coffer-Dam and Its Lessons

The very remarkable coffer-dam now under construction at the foot of 46th St. on the North River at New York City and described in detail elsewhere in this issue is worth the closest attention of the constructing engineer, especially the man engaged in any kind of marine construction. So far as we know, it is to be under a greater head, when completely unwatered, than any other coffer-dam ever successfully completed and at the same time its extreme length increases considerably the liability of localized failure.

A study of its design inevitably calls to mind the famous coffer-dam around the wreck of the "Maine" in Havana harbor, so that a brief history of the behavior of that dam and a comparison of it and the North River dam should be in order.

It will be remembered that the "Maine" coffer-dam was designed to be a series of circular cells, each 50 ft. in diameter, tangentially interlocked to form a closed ellipse about 400 ft. in its major and 170 ft. in its minor axis, with each cell made up of interlocking steel sheet piles and filled to the top with mud taken from the harbor. It was sunk in a depth of 35 ft. of water, with a mud bottom about 120 ft. above rock. The piles were 70 ft. in length, made up of two spliced sections to each unit, and they penetrated about 10 ft. of a dense mud or clay stratum. While precedents for such a design under such adverse conditions of head and material were entirely lacking when the "Maine" coffer-dam was planned by the U. S. Army Engineers, it was the hope that the individual cylinders would act as rigid columns and, while it was not counted upon, that there would be a certain amount of rigidity given the whole structure by the elliptical shape, in other words that some arch action from cylinder to cylinder would take place.

How far these original hopes were realized is shown in the final report of the "Maine" Board, which was published as a government document early this year. From that report, which is incidentally a most valuable engineering treatise, it will be learned that the cylinders were anything but rigid, that they commenced to bulge and distort and even to break under the fill of hydraulically placed mud from the harbor, that the linear distortion of the coffer-dam itself under the low heads of the early unwatering became so great as to require what ENGINEERING NEWS predicted would be necessary, viz., the dumping of riprap against the inside of the coffer-dam and further to require the shifting of the fill inside the cylinders so as to form in effect a continuation of the riprap slope from the inside bottom of the dam up through the cylinder. Finally, before the dam could be completely unwatered, a number of heavy braces had to be set between the cylinders and the wreckage of the "Maine" and one continuous brace had to be placed across the dam.

This final structure was successful in its purpose; the "Maine" was examined, dissected, floated and removed to the ocean bottom outside the harbor, without damage to life, limb or property and the site was restored to the condition it was in before that fateful February of 1898. But instead of an originally estimated $300,000, the total expenditure for the work was $785,774.83 and the final coffer-dam was far different from the original project.

This pioneer work done at Havana served admirably to instruct the engineers of the New York dock department in the things to avoid in the North River coffer-dam. In two respects, the conditions at the two sites were quite similar. Both dams had to be footed in a mud bottom so far above the bedrock as to forbid reaching it with the piles, and both were to hold back very high heads of water, that at Havana averaging 40 ft., with pockets inside the dam reaching 50 ft. below the water level while it is expected the average excavation in the North River will be 44 ft. below low water with the inner toe of the dam about 20 ft. lower. Here the similarity ends, for the Havana dam was a comparatively small closed curve while that at New York is a very long nearly straight line, precluding the possibility of cross-bracing. The similarity is sufficient, however, to make the lesson of the earlier dam useful in the building of the later, particularly in regard to the assumption of rigidity in the filled cells.

In their report, the Army Engineers state that in their opinion the rigidity of the cylinders, and therefore the correctness of the original design, would have been assured had the filling of the cells been made with some solid, dry clay instead of the harbor mud, heavy with water because of its placing by a suction dredge. However, the New York dock engineers apparently are not entirely convinced of the truth of this conclusion, for they have designed a dam, which, while it possesses a family resemblance to its predecessor in Cuba, is in realty a radically different structure, only remotely depending on the cylinder rigidity. It is in effect, a dam of riprap which in turn is retained by a series of mud-filled sheet-pile cells. The inherent rigidity of the cells is assumed to be sufficient only to uphold the cells themselves and to withstand the limited pressure of the riprap backing, which is offset somewhat by the outshore mud backing.

Manifestly, the final expensive efforts to maintain the Havana cylinders as rigid columns will not trouble the New York engineers, but on the other hand, they will be put to an equally serious concern in preserving the balance of load against the cellular core during the progressive removal and placing of the mud and stone fills on either side of the dam. So far the only trouble experienced has been in severe straining, and in two cases rupture of the pile interlock due to the excessive pressure of the interior fill; but when unwatering commences, or even before that when the side loads are placed, the behavior of the dam will be of the greatest interest. Holding back 50 ft. of water across a 800-ft. opening and with a mud fill as a base, is a colossal engineering feat.

The Interstate Commerce Commission's Indictment of the New Haven Railroad Administration

The scathing report of the Interstate Commerce Commission on the financial mismanagement of the New York, New Haven & Hartford R.R., made public last week, is a document whose importance can hardly be overestimated. To a considerable extent, the facts which are set forth by the Commission in its arraignment of the New Haven directors have been known for some time by the well posted in financial circles. The Commission's report, however, now collects all this information and presents it in a most forceful manner, the whole constituting probably the most damning indictment of railway mismanagement on a large scale that has ever been made in this country.

The most important feature of the New Haven wreck is not merely the vast amounts of money which have disappeared like dew before the sun. It is the character of the men and the firms and the companies which were concerned in and were responsible for the wreck. It is well known, of course, that the history of American railroading is full of instances of crooked financing. Since the

very early days of the railway era, there have been railway promoters and railway wreckers, whose methods of doing business have been on a par with those of the green-goods vender, the confidence man, and the vender of wild-cat mine prospects. There always have been pirates on the financial seas; and when they came into control of a property, wise investors knew that it was time to sell out.

But what had the old, conservative New York, New Haven & Hartford R.R. Co. to do with business methods of such a sort? Year after year, and decade after decade, the company went on its way, paying its regular 10% dividends and investing large amounts in excess of these dividends in the improvement of its property. All through New England, stock of the New York, New Haven & Hartford had a reputation equal to that of first-class state or municipal bonds. Men and women invested their money in New Haven stock and thought it was as safe as the savings bank. The directors and officers of the company were largely New England men of good reputation for honesty and conservatism. The great banking firms identified with the property had a reputation for turning everything they touched into gold which even King Midas might have envied. Is it any wonder that when, following the advent of Mr. Mellen to the presidency, the company embarked on a policy of expansion and filled the newspapers with glowing accounts of its great plans for development and extension, New England investors were ready to pour out millions to buy additional New Haven stock and bonds as fast as they were offered.

There seems to be, even now, a considerable degree of misunderstanding as to the real crime of which those who have controlled the New Haven R.R. Co. have been guilty. It is not the traveling and shipping public that has suffered materially. The New Haven R.R. system has on the whole rendered good service and its rates have been on the whole reasonable. The crime committed has been against the owners of the property, those who purchased in good faith its stock and its bonds and to whom the directors were responsible as trustees.

The Interstate Commerce Commissison estimates that the losses to the New Haven stockholders through the dissipation of the company's assets during the past ten years amount to $60,000,000 to $90,000,000. The proceeds of the stock and bonds which have been issued by the New Haven Co. during the last ten years have been used to buy properties at prices far in excess of their true value. Over $30,000,000 was invested in the Westchester enterprise. More than this amount was expended in buying street-lighting and electric-railway properties in Connecticut and much more in the street-railway properties in Rhode Island. Many millions have been lost in the foolish attempt to control the Boston & Maine Co.

The only defense made for these purchases, and in fact the only possible defense, is that those who were responsible for them honestly believed that it was for the interest of the company to purchase these properties at the price paid in view of their future value to the company. It requires a large amount of credulity for one to believe this defense. The financial history of the properties acquired and the way they were acquired; the enormous sums paid to go-betweens; the great amount paid for "accelerating" public opinion, for manipulation of state legislatures—all of these and many other things covered in the report of the Commission and the knowledge of the circumstances and conditions under which the New Haven wrecking operations were carried on all point to the inevitable conclusion that those of the New Haven directorate who were responsible for these huge exploits in high finance were not by any means ignoramuses, but were in fact the hard-headed, shrewd bankers and lawyers and financiers that they were held to be by general reputation.

That somebody profited, and profited enormously, by those exploits in high finance is beyond dispute. The $60,000,000 to $90,000,000 which have been lost by investors in New Haven securities have not been destroyed; they have simply been transferred to the pocket of someone else. It is possible that the courts may be able to unravel some of the financial tangles and compel restitution of some small part of the losses the New Haven stockholders have sustained; but it is at best only a possibility. The statute of limitations and the work of the shrewd lawyers who covered up the processes of high finance, combine to effectually hamper any effort to compel restitution.

It is important that the situation should be clearly understood, however, since there appears to be an attempt to shift the blame from the shoulders of those responsible. It is claimed, for example, that it was State and Federal interference with railway operations in New England that caused the losses of the New Haven stockholders.

For a direct and complete answer to this statement, one has only to take the gross and net earnings of the New Haven Ry. system itself at the present time. In the 11 months ending May 31, 1914, the New York, New Haven & Hartford R.R. Co. earned $60,927,000 gross and $13,291,000 net. These figures put out by the company itself, show conclusively that the railway still earns enormous profits. It is the other enterprises which the New Haven directors foolishly and wickedly loaded upon the railway company, whose deficits and fixed charges absorb the profits that the railway company earns.

It is claimed, however, by those who would defend the New Haven management, that during all the time that the New Haven has been carrying on these exploits in high finance the Federal and State governments have had full authority to control operations; and that if these things were contrary to law and against public policy, the government should have stopped them.

This is indeed pleading the baby act with a vengeance. As well might the burglar arraigned before the court say that he was not responsible for the theft he had committed since the city police department and the private watchman of the bank maintained an organization to prevent such depredation! It seems well nigh incredible that men with a fair degree of intelligence should put forth such a plea and expect it to be accepted at face value.

Another aspect of the New Haven matter on which altogether too much emphasis is laid is the idea that the chief offense of the directors was in attempting to create a monopoly in New England transportation. It is even on the program that a Federal suit is to be brought against the company under the Sherman law.

But as a matter of fact, there has been, for nearly two decades, no important amount of competition in New England. The old New England Ry.,, the only competing railway line between New York and Boston, was absorbed by the New Haven Co. before Mr. Mellen's day.

The much-discussed absorption of the Boston & Maine system by the New Haven Co. did not have, to any important extent, the elimination of competition as its object, for at very few points do the two systems compete with each other.

It was indeed a foolish piece of business for the New Haven to purchase control of the Boston & Maine at the price which was paid; but so far as the traveling and shipping public in Boston & Maine territory is concerned, the only question is whether the old or the new management gives more efficient and economical service.

Even the purchase of the Connecticut and Rhode Island trolley lines cannot be considered to have been in any large degree for the purpose of creating monopoly, although when originally built, these lines did take over traffic which had previously been carried on local steam-railway trains. But the field of the electric-trolley railway and of the steam railway is now well established; each handles the traffic to which it is best suited, and no steam-railway manager with any claims to good judgment would dream of purchasing trolley lines simply to stop their competing with his steam-railway trains.

There is, of course, no doubt that the managers of the New Haven system did attempt to create a monopoly of all rail and water transportation in New England and to a large degree succeeded; but the absolute power of State and Federal commissions to control both rates and service rendered made it impossible for any such combination to reap monopolistic profits. The existence and operation of this power of government control during the years while the New Haven monopoly was in process of creation were perfectly well known to Mr. Mellen and his associates. They knew perfectly well that any attempt to advance rates because of the absence of competition would meet defeat. They knew perfectly well that however much they might perfect their monopoly, the rates they could charge and the service they would be obliged to render would be under public control—a control which has grown and is bound to grow more strict and certain with each succeeding year.

The most important results of the New Haven episode is likely to be its effect on public opinion. It has done more to injure railway credit and make it difficult to sell railway bonds and stocks, both here and abroad, than any similar event in the railway financial world for 25 years. It is today, without doubt, having a powerful influence at Washington upon the appeal for permission to increase freight rates, upon the current acute controversy between the Western railways and their engineers and firemen over a radical increase in wages, upon pending legislation in Congress to establish public control of railway security issues. Those who argue against the increase in freight rates say, "of what avail to give these companies larger revenue when it only gives their banker directors a larger surplus fund to play with in Wall Street. Railway employees, when told that the railway companies cannot afford to grant the increase in wages asked, listen with incredulity and declare that when railways can invest millions of money in all sorts of outside enterprises, they must have money enough to pay higher wages. In the debate upon Federal control of stock and bond issues, it is argued that the officers charged with such control would be governed by political influence and even if honest would be ignorant of the details of corporation finance. Those who favor such control, however, answer this argument by merely pointing to that tangled web of iniquity woven by the New Haven management and say, "could anything be worse than that?"

Still further, no one who keeps in touch with the state of public opinion can doubt that the New Haven wreck has made converts by thousands and hundreds of thousands to the government ownership of railways. That clause which the Massachusetts legislature insisted should be tacked on to every certificate of Boston & Maine stocks taken over by the New Haven, that the State of Massachusetts can at any time purchase the stock at an appraised valuation, is merely a straw showing which way the wind is blowing.

There is at least one constructive and useful suggestion which ought to result from the New Haven wreck, and that is the necessity of a sweeping reform in the method of control of our great public corporations.

In the New Haven wreck, public attention is fixed upon the directors and all the talk is of suits against them to compel restriction. In Washington nowadays the tendency is to treat every director of a great corporation as a man under suspicion. The statesmen (or alleged statesmen) at the Capital are busying themselves with the framing of laws to prohibit interlocking directorates and to find out how to prevent this or that or the other class of men from being elected as directors of the public-service corporations. Not a word is heard as to the solution of the most difficult problem, that of finding men of requisite ability and trustworthiness who are willing to serve as directors of our great corporations and assume the responsibility that should rightly be theirs.

In this very case of the New Haven Company, probably not one in ten of its Board of Directors really knew enough about the affairs of the corporation to fully realize what was going on. Practically all of the directors had their own business and personal affairs to attend to. Membership on the Board of Directors required them to attend, if convenient, a directors' meeting possibly once a fortnight or once a month, at which they voted on such affairs as the three or four leaders in the directorate chose to lay before them.

Such a system of control might perhaps pass muster with the men and the methods of 25 years ago; but it is an absolute failure under the conditions existing today. The board of directors of a great railway or industrial corporation should be made up of men willing and able to devote enough time to the work so that they can fully inform themselves on all the large questions of policy which the board of directors alone should decide. Such directors should be paid enough to command the services of the ablest men, who will regard the office as a public trust instead of considering, as has been too often the case in the past, that membership in a directorate, since it brought no direct compensation of consequence, justified one in making such profits as opportunity permitted from private operations made possible by the knowledge he gained as a director.

With a board of directors paid to devote time to their work, it would be possible to hold them to strict personal and financial responsibility for their acts. If such responsibility is enforced under the present system, however, it simply means that we must be content with a set of men for directors of our public corporations who will be financially irresponsible, since no others could afford to accept such positions.

Letters to the Editor

The Earnings of Technical Graduates

Sir—Under the caption "The Potential Value of Our Engineering Graduates," ENGINEERING NEWS of June 25, prints an extract from the address of Prof. Harold B. Smith, at Clarkson College of Technology, Potsdam, N. Y., in which the Professor says, "the technically trained graduate of our engineering colleges earns annually, on an average, at least $3000."

The average annual earnings of technical graduates who are employed in the bridge and structural engineering departments of the various railroads, bridge and structural shops, engineers and architects are less than one-half of $3000. Further, it is generally understood that those engaged in the bridge and structural line receive a somewhat higher wage than those in the other engineering branches.

Prof. Smith may, by some sort of legerdemain, satisfy his own mind that his is not a gratuitous assertion, but this Clarkson Class of embryo engineers, who received this last injection of university optimism, "bunk," will soon learn their *actual* value as money-getters, and it will be a sad awakening.

HARRY J. BUCH.

14 E. Kinney St., Newark, N. J., June 28, 1914.

A Defense of the Pittsburgh Flood Commission

Sir—In the *Proceedings* of the Engineers' Society of Western Pennsylvania, Vol. 30, No. 2, Mar. 14, 1914, the paper read by Sir William Willcocks on "How the Ancients Would Have Controlled the Mississippi and Its Tributaries," contains certain references to the report of the Flood Commission of Pittsburgh, Penn.

The privilege of an engineer to discuss the work and opinions of his professional brethren is well known and this may even become a duty, if differing profoundly upon important public policies, affecting the safety, health and general welfare of the people. There is, however, a duty, fully as grave and customarily imposed, and that is that one shall completely inform himself before criticizing the position and opinions of others. This is particularly true and the duty is all the more important when the critic occupies a world-wide position of renown and international standing in the profession.

As in this address delivered at the invitation of the Engineers' Society, certain statements appear to attack the methods and findings of the engineering work of the Pittsburgh Flood Commission, the members of the Engineering Committee believe it a duty to the profession, as well as to their associates on the Commission, to answer the sensational criticisms contained therein. The remarks of the author evidently were not based upon an accurate reading of the Flood Commission report. Had he carefully read and considered such report or obtained correct information thereto, it is believed that his views upon the matter of flood control, as applied to our local rivers, would have been materially modified.

(1) The author undertakes to impress his readers that his opinions were based upon personal observations and at the same time to lodge a charge of incomplete investigation against those who have been responsible for the Flood Commission Report. For instance, he says on p. 128:

> I never saw such bad looking stuff for reservoirs, and I found that no one had bored down one foot to see.

As a matter of fact, the author never visited a single reservoir site and fails to show the source of information, hearsay or otherwise, upon which he was relying for his extravagant statements. Upon the other hand, members of the Engineering Committee of the Pittsburgh Flood Commission visited the site of each proposed dam and satisfied themselves fully as to the presence of natural rock formation.

(2) Again on p. 128, the author says:

> And your condition is such that if you had a high flood and a reservoir with 150 ft. head on the hills above you, and it happened to breach and come on top of the flood, all of the disasters you know of today would be but child's play. And if you had two in the same valley and the upper one burst and came down on the lower one, and the two came together, you might open the early chapters of Genesis and begin reading about Noah's flood to comfort you.

The purpose of the author's pleading is not clear. If he is adverse to dams of 150 ft. or more in height, because these are dangerous, we respectfully call attention to the fact that the highest dam proposed by the Commission is 143 ft. in height and the average of the seventeen dams proposed is 93 ft. However, we further note that there are several dams in this country of more than 200 ft. in height. Height simply requires adequate design and strength.

(3) Upon p. 127 of the paper, the following statement occurs:

> This horizontal sandstone you have here and shale in alternating strata is considered the worst foundation for reservoirs of anything in the world. More accidents to big reservoirs have happened on it than any other. If the strata are inclined at a steep angle and you build your dam on it, it rests on the hard particles and the weak strata are more or less ignored.

As the author very shrewdly abstains from giving definite information as to who holds these absurd opinions as to our local geological conditions and as we are addressing those who have knowledge of these matters, comment is unnecessary.

(4) Upon p. 128, the author states:

> In your book you show that you spent money on many things, but not one penny to show what your foundations are, and all the rest of it is worth nothing until you are sure of your foundation. You ought to spend some $10,000 for drills and take two of the nearest sites and expose the foundation and see if you can build a dam there. If you find real good foundation your difficulties will be at an end.

Engineers of ability and experience engaged upon a preliminary study and general design, judge by the surrounding out-cropping crock, which indicates geological

conditions. Thus the feasibility of location is determined and customary allowance made in estimates of costs for depths of foundations. Later drillings will determine actual design and depth.

Without undertaking to give detail answer to this criticism and show how the money was spent, all of which is stated in the report thus mentioned, the engineers of the Flood Commission, after personal inspection of the sites, considered that it was unnecessary to spend any money for borings for the purpose of their preliminary report. But it goes without saying that before actual sites would be determined and building begun, such borings would, of course, be made by those responsible for the design and construction.

(5) Upon p. 123, it is further stated:

> In a recent book which you have written on this reservoir question I see that the quantity of water you consider necessary to impound in these reservoirs seems to be in excess of what you need. In all the calculations it has been assumed that when the river rises, its discharge increases up to its maximum stage. . . . As in all these estimates, you have allowed for an increasing discharge and not reduced by half for the falling gage, a much smaller quantity of water than you have assumed would, I think, suffice to shelter you from these hours of high flood which produce all the worry.

This appears to be a criticism of the use, by the Flood Commission Engineers in their report, of a greater factor of safety than the author thinks necessary. It may be stated that the hydraulic measurements, upon which the quantities were determined, were based upon the careful methods of the United States Geological Survey and of the Pennsylvania Water Supply Commission and many of the stations were operated in coöperation. Full and complete allowances were made in the rating curves, notwithstanding the above quoted comment, for the fact that river velocities are not the same upon rising and falling stages. This statement can be verified by reference to the rating diagrams in the report.

(6) The weakness of the author's paper and of the apparent criticisms of the Flood Commission's report are due to two facts: The opinions expressed in the report were based upon five years' study by engineers who possessed full knowledge of local circumstances and who therefore do know, whereas the remarks of the author emanated from a necessary cursory and hasty examination of the subject and conditions.

(7) The Engineers of the Pittsburgh Flood Commission have the highest appreciation of the professional and ethical responsibility of opinions upon such a question as flood control and regret that so eminent an engineer should undertake to speak to the world upon such an important subject without fully informing himself as to the data from which he draws his conclusions.

Geo. I. Davison,	M. Am. Soc. C. E., Past-President Eng. Soc. of Western Pennsylvania.
Paul Didier,	M. Am. Soc. C. E.
George M. Lehman,	M. Am. Soc. C. E.
Julian Kennedy,	Past-President, Eng. Soc. of Western Pennsylvania.
Morris Knowles	M. Am. Soc. C. E.
E. K. Morse	M. Am. Soc. C. E., Past-President, Eng. Soc. of Western Pennsylvania.
Emil Swensson,	M. Am. Soc. C. E., Past-President, Eng. Soc. of Western Pennsylvania.
W. G. Wilkins,	M. Am. Soc. C. E., Past-President, Eng. Soc. of Western Pennsylvania.

MEMBERS ENGINEERING COMMITTEE,
PITTSBURGH FLOOD COMMISSION.

Pittsburgh, Penn., July 17, 1914.

Brick-Pavement Repairs

Sir—I have read with much interest your editorial comments in ENGINEERING NEWS, July 2, 1914, on "The Neglect of Brick Pavements," and I fully agree that from whatever cause a repair is needed in any kind of a road, including a brick road, it should have immediate and prompt attention. But I must take exception to one or two statements made in the editorial, also to the form of remedy suggested.

First, your statement:

> On many miles of brick paved roadways in Cuyahoga County, Ohio, which have been laid within a comparatively short time and are good examples of first-class construction, the only defect noticed is longitudinal cracks extending along or near the center of the roadway.

The objection to this statement lies in the fact that they "are good examples of *first-class construction.*"

Many of your readers will recollect the paper read before the American Highway Association in Detroit last October by James M. McCleary, a Cuyahoga County road engineer, whose connection with the building of these roads covers a period of 20 years.* Mr. McCleary not only confessed errors in construction and the slowness with which mistakes were corrected, but pointed out in detail many of the mistakes, one admitted defect particularly being a lack of drainage.

Even where some effort at drainage was made, a confession followed that the very methods employed in drainage were such as would be expected to bring about the moist condition underneath the pavement and develop the cracks from the effects of low temperature of which you speak. So these cracks are not in roads which are good examples of *first-class construction.*

Quite the contrary is found in the fact that there are perhaps an equal number of miles of brick roads and streets in Cuyahoga County, which approach examples of *first-class construction.* In these, no cracks whatever appear, a condition that may be expected to obtain in cases of properly constructed brick streets, where the danger of cracking is intelligently and scientifically provided for.

Strictly speaking, it may be a fallacy that a brick pavement when once well laid, needs no repairs whatever. While I do not want to be in a class that would take such an extreme position, still the public should know the truth; which is, that if a brick pavement is properly constructed, the repairs are merely a negligible consideration and do not amount to even as much as Governor Glynn declares, to wit: $50 per mile per annum. This is not an extravagant statement to make in view of the fact that a great many miles of brick streets and roads have been built and are in constant use with much more than an average traffic, and have not needed a dollar for repairs, and will probably not need any repairs for many years to come.

I think your suggestion as to the manner and method of repair where these repairs are needed is unfortunate. In the judgment of the writer, the only practical and economical way to repair a brick road is to restore the pavement to a condition in accord with the original construction both as to manner and method. This is not quite so easily done as in the way suggested.

WILL P. BLAIR,
Sec'y, National Paving Brick Manufacturers' Association.

Cleveland, Ohio, July 11, 1914.

*For abstract of Mr. McCleary's paper see "Engineering News," Oct. 16, 1913, pp. 749, 750.—Ed.

The Coffer-Dam for the 46th St. Pier, North River, New York City

The deepest and one of the largest coffer-dams ever built is now under construction on the North River at the foot of West 46th St., Borough of Manhattan, New York City, to be used in laying bare the site of the shore end of a new 1000-ft. pier being built there by the City of New York. The coffer-dam is made up of continuous cells of steel sheet piling and is similar in construction to the dam used in the construction of Black Rock harbor in Buffalo, and somewhat similar to the famous coffer-dam, which inclosed the ruins of the "Maine" when the wreck of that vessel was raised some years ago. Profiting by the experience gained in these two dams, however. the engineers are backing the sheet-pile cells with a very heavy filling of riprap, so that in effect the pockets of steel sheet piling form the seal of the coffer-dam, and are held in place by the riprap fill.

Design of the Pier

The increasing demands of the extraordinarily large vessels now berthing in the North River has led the City of New York to the construction of 1000-ft. piers in the North River and the location selected is the Manhattan side of the river north of 42nd St. The first construction in this new location was authorized for the foot of 46th St. about a year ago. It was intended at that time to build a 1000-ft. pier directly at the foot of 46th St. with berths on either side and to defer the construction of a half pier at 44th St., providing an additional berth to the north, until property rights could be acquired later. However, within the past few months the city has acquired full rights at 44th St., so that the work now under construction comprises a pier 150 ft. wide and 1000 ft. long, at the foot of 46th St. with berth to the north and to the south 1000 ft. long, and a half pier on the northerly side of 44th St. 1000 ft. long with a 1000-ft. berth to the north.

The coffer-dam, which is to inclose the shore end of this area, extends then from 47th St. to 44th St. The whole contract comprises the placing of about 3500 to[ns] of steel in the coffer-dam, 99,000 cu.yd. of riprap in t[he] embankment, the removal of 76,000 cu.yd. of rock a[nd] the placing of 14,000 cu.yd. of concrete masonry. T[he] whole basin created by the coffer-dam will cover an ar[ea]

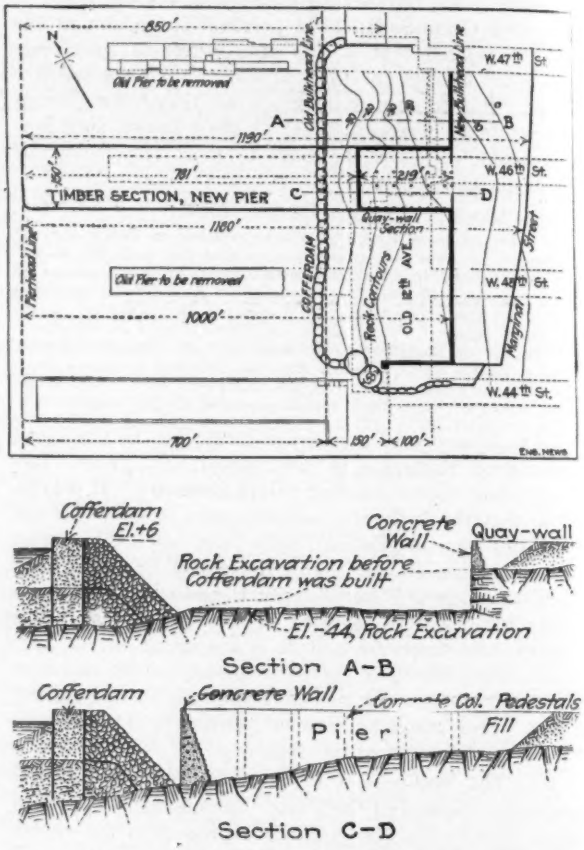


Fig. 1. Plan and Sections of New Pier at Foot of W. 46th St., North River, New York City, Showing Location of Coffer-Dam

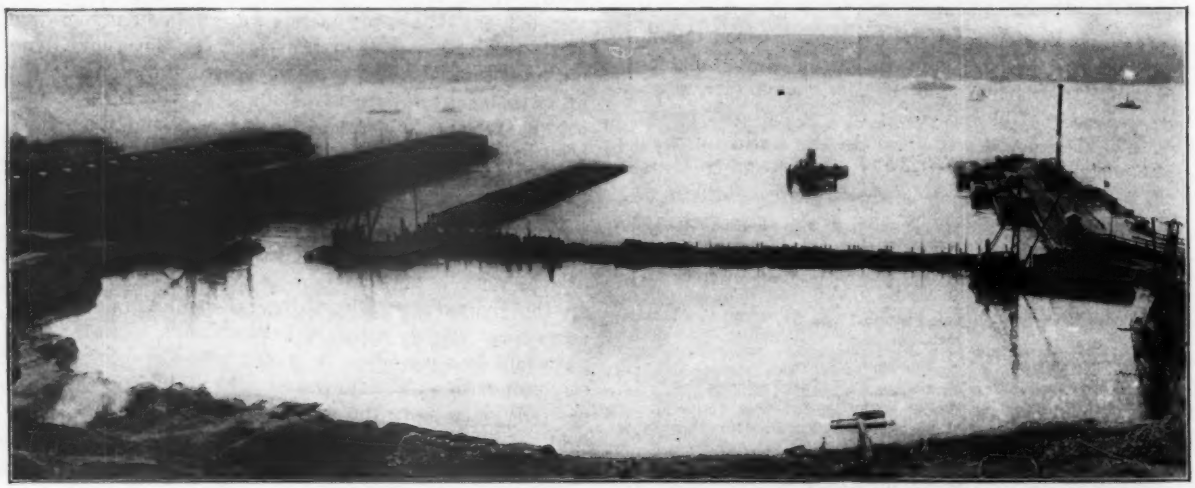


Fig. 2. View of North River, Foot of W. 46th St., July, 1914, Showing Coffer-Dam Partly Completed and Shore Excavation Made

of about 800 ft. in length and 300 ft. in width, requiring about 55,000,000 gal. of unwatering. The greatest head on the coffer-dam will be over 65 ft.

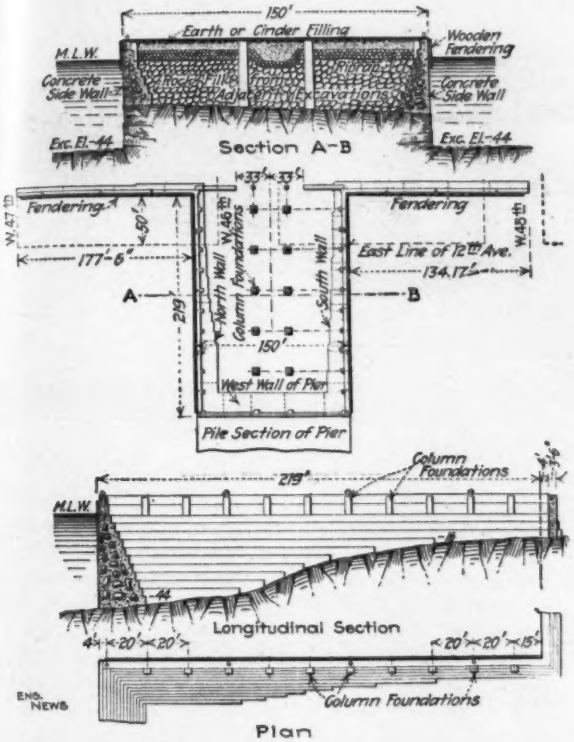
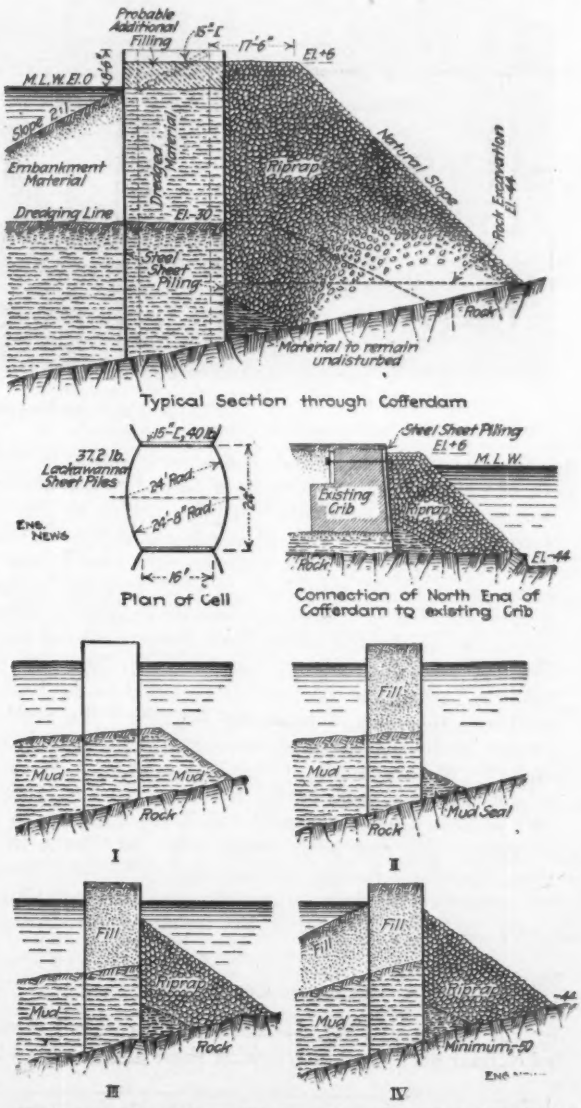


FIG. 3. DETAILS OF QUAYWALL AND FILL CONSTRUCTION OF 46TH ST. PIER

The pier-head line in the North River at this location is 700 ft. riverward from the old bulkhead line, so to provide a 1000-ft. dock it is necessary to extend the bulkhead line inshore some 300 ft. Borings and soundings at the site showed the following conditions: Along the new bulkhead line rock was found at an average depth of about 20 ft. below mean low water. Running outshore at a distance of about 220 ft. rock was found at a depth of about 44 to 50 ft. below water. From this point outshore the rock slopes off at a uniform grade, at the pier-head line rock was found at a depth of about 150 ft. below mean low water with an overlying layer of soft mud. The ships for which the new docks are designed require nearly 40 ft. of water, and it was felt that excavations should be carried to at least a depth of 44 ft. below low water to insure safety in berthing in extreme low tide. It, therefore, was necessary to excavate at the shore end of the berth a ledge of rock running from 20 ft. in depth near the bulkhead line to zero about 250 ft. from that line.

At the same time the nearness of the rock to the surface near the shore line made exceptionally desirable the construction at that end of the pier of a filled-in quaywall rather than the ordinary pile-pier construction common to New York harbor. For these reasons it was decided to build the pier 1000 ft. long with a shore end of 219 ft. of gravity section concrete wall filled behind with riprap and earth and with the outshore 781 ft. of ordinary timber-pile construction. On p. 194 of this issue is a note, with a view, describing the test piles driven in preparation for this outshore section.

For the construction of the shore section, underwater excavation of the rock was considered, but because it was very necessary that the rock bottom as excavated should



(Note that the outshore fill shown in stage IV is deposited in part in stage III. See text.)

FIG. 4. DETAILS OF COFFER-DAM FOR 46TH ST. PIER AND DIAGRAM, SHOWING SUCCESSIVE STAGES OF CONSTRUCTION

be comparatively smooth and well below the bottoms of the vessels entering the berth and furthermore because in the estimate it proved more economical, it was decided to inclose the entire shore area with a coffer-dam, to unwater the area and to excavate the dock areas by rock excavation in the open, leaving the rock under the quaywall and pier section at its natural elevation and leaving, furthermore, a sheer wall at the quaywall, so that there would be presented a smooth, vertical wall from the river bottom at the dock to the top of the pier. (See Fig. 3 for details of the pier design.)

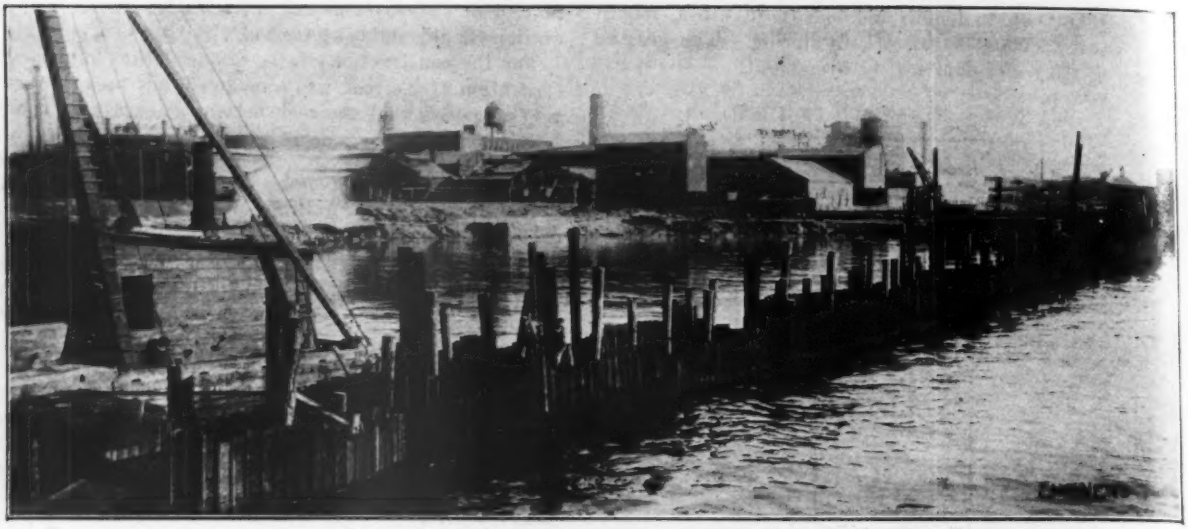


FIG. 5. VIEW OF COFFER-DAM UNDER CONSTRUCTION

The coffer-dam to be built had to be driven in 20 to 30 ft. of water with an underlying mud to the rock surface, which required a total length of piles making up the coffer-dam of some 70 ft. This extreme depth, together with the very heavy head that the dam would have to carry, required an exceptional type of dam and the engineers decided to utilize the cellular sheet-pile method noted above. In the Black Rock harbor coffer-dam, at Buffalo, and particularly in the coffer-dam of the "Maine," which was considerably deeper than the Buffalo dam and therefore more nearly resembled the problem in the North River, a first attempt was made to insure stability of the dam by filling the cells with the mud or silt excavated from behind the dam. In the "Maine" this proved quite unsuccessful and it was necessary to fill in behind the dam with riprap. In the North River dam, therefore, it was decided to forestall any future movement of the dam by providing at the beginning a heavy fill of riprap against the inside of the sheet-pile fill.

DESIGN OF COFFER-DAM

The dam used (Fig. 4) consists of a corewall formed of cellular pockets of interlocking sheet piles, each pocket being about 16 ft. in width and 24 ft. in length with an embankment of riprap on the shore side with a width of 17½ ft. and an elevation 6 ft. above mean low water, with a natural slope of 1 on 1 and with an embankment of earth along the outshore, or water face up to mean low water.

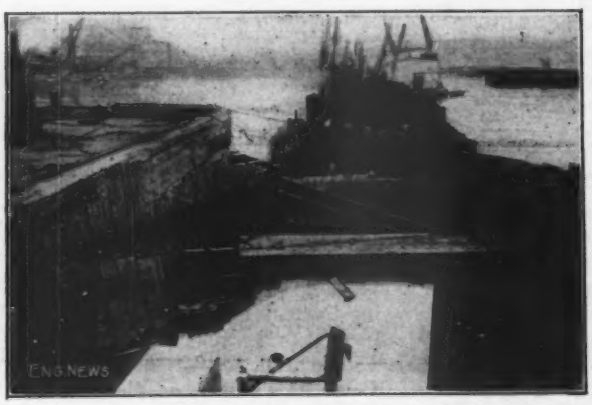


FIG. 6. A BREAK IN THE TRANSVERSE WALL BETWEEN TWO CELLS OF COFFER-DAM

The cells are made up of the Lackawanna sheet piles of the 37.2-lb. sections, capable of safely resisting a jaw tension of 9500 lb. per lin.in. Each cell consists of two slightly rounded outer walls with joining transverse straight walls, which are additionally braced by a heavy channel crossing the wall and bolted to each separate sheet pile (Fig. 6). This cross channel was devised to give additional stability during the construction of the pockets. The ends of the coffer-dam are joined at the north end to an existing crib by framing one of the sheet piles of the last cell into a straight single line of sheet piles, which in turn are tied back with tie rods to the interior of the crib work (Fig. 7). At the south end the shore end runs up to above water with a single line of sheet piles. The connection of one cell to another is made with a three-way special sheet pile, designed for this purpose. One may be noted in Fig. 7.

As is shown in Fig. 1, two of the cells are circular in plan and of much larger size than the standard; this is imposed by the necessity of clearing the corner of the existing pier at the foot of 44th St.

The progressive steps in building the dam are shown on the diagram on Fig. 4. The first step in the construction was to destroy the inshore portions of the old existing pier, then to dredge to rock within the area included between the new bulkhead line and a point about 240 ft. west of it. This included both under-water dredging and the excavation of a previous shore section. The coffer-dam cells were then driven across the opening just riverward of the dredged section, so that the piles were driven through an overlying 20 ft. or more of mud and silt. These conditions are shown under step I, in Fig. 4.

Step II was to tub out the mud lying on the shore side of the coffer-dam and into the cell of the dam, leaving a seal of the mud at the inner toe of the dam. Step III is to place the fill of mud up against the river side of the

coffer-dam and to dump the riprap against the shore side of the dam, and step IV will be to pump out the dam. Examination of the diagram showing these steps will show that at various times during the process the dam would be in rather precarious state of equilibrium if the processes indicated on the steps were continued entirely across the dam. For instance, in step III, if the riprap were placed entirely before the fill was placed on the river side of the dam, as the diagram shows in step III, there would be a pronounced tendency to turn over toward the river.

In order to avoid such possibility the filling and excavating on either side of the coffer-dam are now being carried out with extreme caution in alternate sections along the dam, so that no great length of the dam is subjected to excessive pressures from either side at any one time.

FIG. 7. NORTH END OF COFFER-DAM, SHOWING CONNECTION TO EXISTING CRIB

The present state of the dam is shown in the large view in Fig. 2. A considerable portion of the cells has been driven and the dredges are working, filling the cells and the dam. The fills inside the cells cannot be completely made with the tubbed-out material inside the dam and the fills in upper part of the cells are to be made by wagons from shore, driven out over the coffer-dam on plank laid across the top of the cells.

Some little trouble has been experienced in driving the closure piles of each cell and in two cases at least the driving has put such a strain upon the pile as to cause them to break. Fig. 6 shows a break of such a nature in one of the cross walls between two adjoining cells.

PERSONNEL

The pier has been designed and is being constructed by the Department of Docks and Ferries of the City of New York, R. A. C. Smith, Commissioner of Docks and Ferries, and C. W. Staniford, Chief Engineer of the Department.

Holbrook, Cabot & Rollins, of Boston and New York, hold the contract for the work which has been described.

Standards of Water Purification and Sewage Treatment

The following standards of water purification are a result of a conference of eminent sanitary engineers, held at the request of the International Joint Commission, to aid the Commission in its investigation of the pollution of the Great Lakes. The engineers asked to participate were George W. Fuller, George C. Whipple and Earle B. Phelps for the United States and F. A. Dallyn, W. S. Lea and Theo. J. Lafreniere for Canada. These engineers were submitted a list of questions on which a general discussion took place. As a result, a resumé was drawn up and signed by all of the engineers except Mr. Dallyn, who objected to several points and asked for the elimination of paragraphs 5, 7 and 11. The other members could not consent to this, so Mr. Dallyn's name was left off the statement, which follows:

1. Speaking generally, water supplies taken from streams and lakes which receive the drainage of agricultural and grazing lands, rural communities, and unsewered towns are unsafe for use without purification, but are safe for use if purified.

2. Water supplies taken from streams and lakes into which the sewage of cities and towns is directly discharged are safe for use after purification, provided that the load upon the purifying mechanism is not too great and that a sufficient factor of safety is maintained, and, further, provided that the plant is properly operated.

3. As, in general, the boundary waters in their natural state are relatively clear and contain but little organic matter the best index of pollution now available for the purpose of ascertaining whether a water-purification plant is overloaded is the number of B. coli per 100 c.c. of water expressed as an annual average and determined from a considerable number of confirmatory tests regularly made throughout the year.

4. While present information does not permit a definite limit of safe loading of a water-purification plant to be established, it is our judgment that this limit is exceeded if the annual average number of B. coli in the water delivered to the plant is higher than about 500 per 100 c.c., or if in 0.1 c.c. samples of the water B. coli is found 50% of the time. With such a limit the number of B. coli would be less than the figure given during a part of the year and would be exceeded during some periods.

5. In waterways where some pollution is inevitable and where the ratio of the volume of water to the volume of sewage is so large that no local nuisance can result, it is our judgment that the method of sewage disposal by dilution represents a natural resource and that the utilization of this resource is justifiable for economic reasons, provided that an unreasonable burden or responsibility is not placed upon any water-purification plant and that no menace to the public health is occasioned thereby.

6. While realizing that in certain cases the discharge of crude sewage into the boundary waters may be without danger, it is our judgment that effective sanitary administration requires the adoption of the general policy that no untreated sewage from cities or towns shall be discharged into the boundary waters.

7. The nature of the sewage treatment required should vary according to the local conditions, each community being permitted to take advantage of its situation with respect to local conditions and its remoteness from other communities, with the intent that the cost of sewage treatment may be kept reasonably low.

8. In general, the simplest allowable method of sewage treatment, such as would be suitable for small communities remote from other communities, should be the removal of the larger suspended solids by screening through a ¼-in. mesh or by sedimentation.

9. In general, no more elaborate method of sewage treatment should be required than the removal of the suspended solids by fine screening or by sedimentation, or both, followed by chemical disinfection or sterilization of the clarified sewage. Except in the case of some of the smaller streams on the boundary, it is our judgment that such oxidizing processes as intermittent sand filtration, and treatment by sprinkling filters, contact beds, and the like, are unnecessary, inasmuch as ample dilution in the lakes and large streams will provide sufficient oxygen for the ultimate destruction of the organic matter.

10. Disinfection or sterilization of the sewage of a community should be required wherever there is danger of the boundary waters being so polluted that the load on any water-purification plant becomes greater than the limit above mentioned.

11. It is our opinion that, in general, protection of public water supplies is more economically secured by water purification at the intake than by sewage purification at the sewer outlet, but that under some conditions both water purification and sewage treatment may be necessary.

12. The bacteriological tests which have been made in large numbers under the direction of the International Joint Commission indicate that in some places the pollution of the boundary waters is such as to be a general menace to the public health should the water be used without purification as sources of public water supply, or should they be used for drinking purposes by persons traveling in boats.

13. It is our judgment that the drinking water used on vessels traversing boundary waters should not be taken indiscriminately from the waters traversed, unless subjected to adequate purification, but should be obtained preferably from safe sources of supply at the terminals.

14. While recognizing that the direct discharge of fecal matter from boats into the boundary waters may often be without danger, yet in the interest of effective sanitary administration it is our judgment that the indiscriminate discharge of unsterilized fecal matter from vessels into the boundary waters should not be permitted.

M

A Combination Brick and Asphalt Pavement—Sheet asphalt for the middle section of the street and brick pavement on the sides and gutters—is suggested by the City Solicitor of Hamilton, Ohio, as a solution of that city's paving problem. It is claimed that this type of pavement has proved successful in other cities.

A Relic of Some of New York City's Early Water-Works

The accompanying views show the demolition of a cast-iron storage tank of the Manhattan Co., built about 18[illegible], at the corner of Reade and Centre Sts., New York City, as a part of the water-works which supplied the lower part of the city from about 1799 until the introduction of Croton water in 1842.

Walled in by an old building, this interesting relic has existed for over 100 years, forgotten by practically everyone but the owner of the property, the Manhattan Co., which, due to one of those curious legal fictions, must maintain the semblance of a water-works plant in order to keep its charter; and this charter of the Manhattan Co. is a valuable document, since, under a "joker" clause, it has built up one of the greatest banking institutions in the city. The water-works company will continue by a similar fiction of maintaining a 25-ft. diameter well, which is under the tank and its masonry substructure.

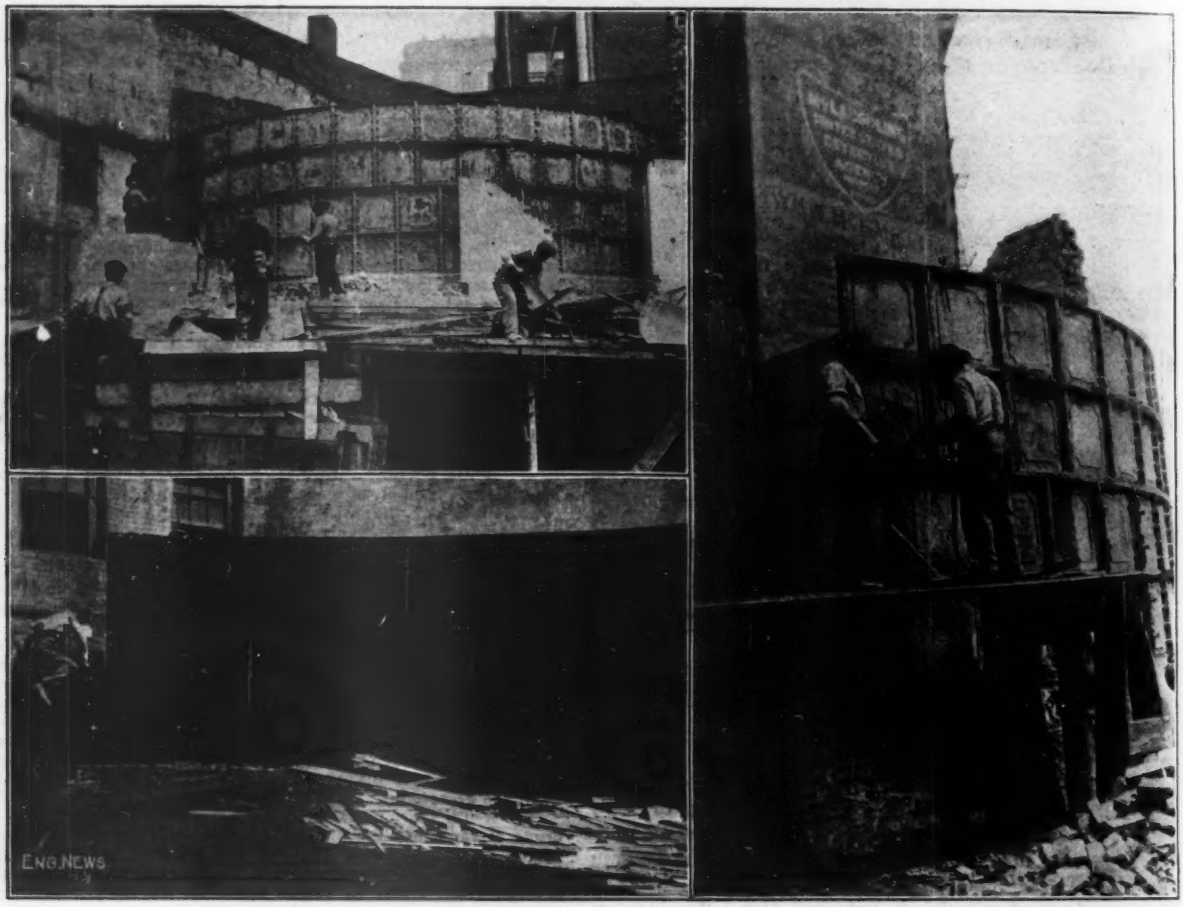


FIG. 1. DEMOLISHING OLD CAST-IRON WATER TANK OF THE MANHATTAN CO., NEW YORK CITY

THE EARLIEST CITY WATER-WORKS—New York City had a water-works system as early as 1774, when Christopher Colles built a reservoir on Broadway near the present Leonard and Franklin Sts., together with a pumping plant operated by two Newcomen's atmospheric steam engines, and water mains in many of the downtown streets, of pipes made of bored logs. These were in use in 1776,

but the War of the Revolution and accompanying troubles put an end to the water-works company.

HISTORY OF THE MANHATTAN COMPANY—From then until the Manhattan Co. began operations in 1799, the city had no public water-supply. This granting of a

FIG. 2. CAST-IRON FLOOR PLATES OF OLD TANK

charter to the Manhattan Co. was a historic event, and thereon hangs a tale, which is related in a booklet published by the Manhattan Co., as follows:

Corporate banking in New York began with the organization of the Bank of New York by Alexander Hamilton in 1784, which received its charter in 1792. For 15 years this bank, together with the New York branch of the first Bank of the United States were the only banks doing business in either the city or state of New York. With Hamilton and the Federalists in control of the legislature, new bank charters were unobtainable. This monopoly of banking facilities in the city and state was of great strategic value to the political party in control, and naturally aroused jealousy and resentment among the members of the opposition, whose leader was Aaron Burr.

In 1798 New York City suffered from a severe yellow fever epidemic, which was attributed to an inadequate and inferior water supply. Upon the assembling of the legislature in 1799, an association of individuals, among whom Aaron Burr was the moving spirit, applied for a charter for the purpose of "supplying the city of New York with pure and wholesome water." With a capital of $2,000,000 the project was an ambitious one for those days, and, as there was considerable uncertainty about the probable cost of the water-works system, a clause was inserted in the charter permitting the company to employ all surplus capital in the purchase of public or other stock, or in other monied transactions or operations, not inconsistent with the constitution and laws of New York or of the United States.

A great effort was made to defeat the charter on account of this clause granting the company banking privileges. But the necessity for a proper water-works system, which could be secured only by the organization of a responsible company with large capital, carried it through the legislature, and it received the governor's signature.

The first meeting of the directors was held on Apr. 11, 1799. Dan Ludlow was chosen president, and the following minute was made:

The principal object of this incorporation being to obtain a supply of pure and wholesome water for the city of New York,

Resolved, That Samuel Osgood, John B. Coles and John Stevens be a committee to report with all convenient speed the best means to be pursued to obtain such supply.

On May 6, 1799, the water committee was empowered to contract for as many pine logs as they might think necessary for pipes, and also for boring the same.

A number of wells were sunk, reservoirs and tanks built, and the distributing system extended generally through the city south of city hall.

About 1836 the system was extended north along Broadway as far as Bleecker St., and at that time the company had about 25 miles of mains and supplied 2000 houses.

A 40x20-FT. CAST-IRON TANK—Of the reservoirs operated by the Manhattan Co., the cylindrical cast-iron tank at Reade and Centre Sts. has been apparently the sole survivor. This tank was an interesting example of early 19th century water-works engineering. It was about 40 ft. in diameter, built of cast-iron segments about 2½ ft. wide by 4½ ft. high and fully ⅝ in. thick. The plates were bolted to one another through outside flanges on all four sides of the plates and each plate had a transverse rib in the middle. The inside of the tank presented a smooth surface. The joints between the plates were evidently filled with an iron cement, apparently salamoniac and iron filings. The tank was about 20 ft. high. The cast-iron plates were imported from England.

As one of the views shows, there was about 4 ft. of water in the bottom of the tank; from all appearances, there had been water there from time immemorial. When the water was removed, there was a black, slimy, greasy sediment 4 or 5 in. deep, of about the consistency of axle-grease, which gave eloquent evidence of the character of the water that has filled the tank during recent years, at least. The bottom plates, after this deposit had been removed, showed almost no corrosion. According to con-

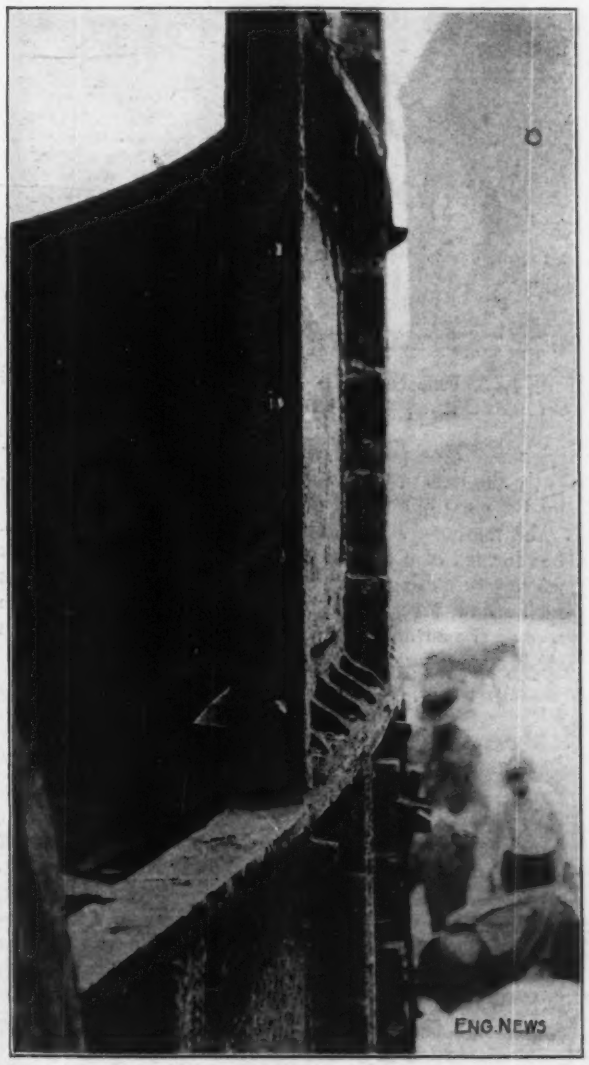


FIG. 3. NEAR VIEW OF CAST-IRON PLATES

temporary reports the water was always notoriously bad.

All the side plates are still good sound iron; few had apparently lost more than one-quarter of their original thickness, although, in removing the plates, rust scale on the interior of the tank fell off in sheets several feet square. It is, of course, impossible to tell whether the interior was ever painted or coated in any way, but evidently the best protection of all had been the scale itself, and the good quality of the iron.

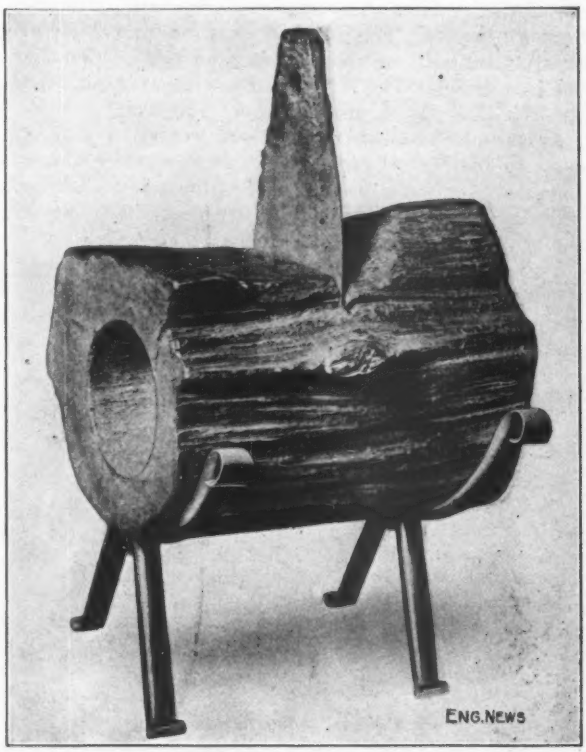


FIG. 4. A PRIMITIVE GATE-VALVE; DUG UP IN PARK ROW, NEW YORK CITY, IN 1900

The masonry substructure is of curious construction. It is formed of a central pier with radial arches of brick masonry extending to an outside row of piers. The inlet and outflow pipes were cast or wrought iron; and the valve on the outflow pipe was of a gate-valve design, with a rising stem screw.

Proposed Improvements in Municipal Street Cleaning; New York City

In a recent report on a proposed model street-cleaning district in the Borough of Manhattan, New York City, J. T. Fetherston, Commissioner of Street Cleaning, points out the possibility of introducing many improvements and economies. The system now in use in New York City is practically the same as that installed by Col. G. E. Waring over 17 yr. ago.

The main feature of the new plan, which is novel only in its adaptation to municipal conditions, replaces horse-drawn vehicles with power-driven motor tractors, each fitted with three types of trailers; one for street flushing or sweeping, one for refuse collection, and the third for plowing, sweeping and hauling snow. The remainder of the equipment will consist of standard types of covered receptacles for holding garbage or ashes, and a transfer station or dump provided with power-operated devices for handling refuse.

TRACTOR-TRAILER OUTFITS—For the proposed model district, 12 tractors of the nominal 5-ton type, with 36 trailers, will be required. These will be equivalent to 36 single trucks and constitute the main feature in the new scheme. No other city has taken up the tractor-trailer system, but it is successfully employed by private companies. Its adoption for municipal street cleaning, Mr. Fetherston believes, will solve the problem of decreasing the fixed charges by extending the functions of the trailers and the hours of work of the tractors.

Each tractor, as already noted, will be provided with three types of trailers. For collecting refuse, a trailer body fitted with removable compartments to hold at least 10 cu.yd. of refuse will be provided and so designed that material from the standard cans will be transferred to an appropriate compartment without creating dust or nuisance. All classes of refuse will be collected at one time, and not more than one collection trip per day will be made through any street. This will result in all cans being removed from sidewalks and areas except at the removal period, which can be closely timed for every street.

For cleaning streets, a trailer containing a water tank holding about 1500 gal. with sprinkling, flushing and revolving-broom attachments will be furnished, and for snow work a plow and revolving broom, following street-railway practice, is contemplated. Manufacturers of auto trucks have been consulted as to cost and feasibility of the combination tractor-trailer system and have decided the apparatus to be both practical and economical.

DUMP AND TRANSFER STATION—The transfer station or dump will consist of a closed shed on a pier following the general type of shed built along the waterfront, using structural-steel members covered with galvanized-iron sheathing. An electrically operated telpher system will unload refuse containers from vehicles and transfer the material to scows moored alongside the dock. Until the existing contracts for final disposition expire on Jan. 1, 1917, it will be necessary to use the present scows, but later they will be fitted with steel compartments or containers to hold refuse, instead of piling it loosely on the deck to be scattered on the water by the wind while in transport. On account of the picking contract now in force, it will be necessary to construct a temporary rubbish incinerator on the pier, but on the expiration of this agreement (Jan. 1, 1917) all trimming and picking will be eliminated at the transfer station.

The transfer station will become the headquarters for the district and will be provided with an office, employees' dressing rooms, lockers, shower baths and all suitable appurtenances for the work. Temporary storage of refuse pending the arrival or shifting of scows will be provided by means of 24 steel receiving tanks each of 20 cu.yd. capacity. In operation, such a transfer station will eliminate present nuisances at the waterfront dumps.

ESTIMATED COST—The model district proposed contains a population of 130,000, an area of 900 acres, has 50 miles of streets and 807,555 sq.yd. of pavement. The district includes wholesale and retail business, residences, tenements, manufacturing plants, apartment houses, pub-

lic institutions—in fact is thoroughly representative of city conditions. The accompanying Table I shows the estimated cost of the plant described for this district.

TABLE I—COST OF TRACTOR-TRAILER PLANT

Equipment	Total Investment
Shed at dock, 12,500 sq.ft. @ $1.35	$16,875
Telpher track, 1500 lin.ft. @ $5	7,500
Telpher switches, 8 @ $200	1,600
3 telphers complete, $5000	15,000
Temporary rubbish incinerator and belt	10,000
Plumbing and heating	3,000
Electrical work	3,000
Office and equipment	1,000
24 steel receiving tanks (8x8x10) @ $300	7,200
12 tractors and trailers complete @ $10,000	120,000
26,000 special refuse receptacles @ $1.25	32,500
3 auto runabouts	1,800
Engineering—Design and tests	21,500
Contingencies	12,025
Total	$253,000
Annual interest @ 4½%	$11,385

The accompanying Table II gives the estimated cost of operation of the tractor-trailer plant and equipment, which represents an estimated saving of $54,342 over the present methods.

TABLE II—ESTIMATED ANNUAL COST OF OPERATION, MAINTENANCE AND FIXED CHARGES, TRACTOR-TRAILER METHOD

Item	Street Cleaning	Refuse Collection	Snow Work	Totals
Operation and Maintenance	$186,300	$77,412	$15,688	$279,400
Interest	2,365	5,081	1,059	8,505
Depreciation	998	15,643	439	17,080
Totals	$189,663	$98,136	$17,186	$304,985

Municipal Ownership and the Commissioner of Utilities at Port Arthur, Ont.

It is doubtful wheter any other city this side of the Atlantic has gone farther in municipal ownership than Port Arthur, Ont. It owns and operates a street-railway system, electric lights, power service, telephones and water-works. In addition to its extensive ownership of public utilities it adopted what is virtually the city-manager plan about three years ago, or before the plan was more than launched in the United States.

The City Council of Port Arthur appointed J. J. Hackney Commissioner of Utilities in August, 1911. Mr. Hackney has direct control of the eight following city departments: Street Railway; Electric Light; Power; Telephone; Water-Works; Collection; Purchasing; Street Lighting. Besides, he has a general supervision of the Fire and other Departments of the city.

Mr. Hackney informs us that besides making all purchases, all bills are approved by him before being passed by the City Council. He also states that he reports to the Council and that the relations between him and the Council "have been very, very agreeable," with "an entire absence of friction."

The tax rate of Port Arthur for 1914 is 20.5 mills on the dollar, including the school tax. Mr. Hackney states that this is about the lowest rate in Canada for the current year and says considerable credit therefor "is due to the surpluses from the utilities."

The financial results of municipal ownership at Port Arthur are thus summarized by Mr. Hackney:

The following are the gross gains of the Utilities Department for 1913, showing the percentages on the capital invested. This would be the amount that in the case of private companies would be available for dividends. Of course, in Canadian municipal corporations we issue debentures for our capital construction, and take care of interest and sinking fund thereon.

ELECTRICAL DEPARTMENT

Gross revenue	$174,733	
Operating expenses	66,869	
Gross gain		$107,864

TELEPHONE DEPARTMENT

Gross revenue	$46,097	
Operating expenses	26,573	
Gross gain		$1,728

WATER-WORKS DEPARTMENT

Gross revenue	$51,465	
Operating expenses	23,833	
Gross gain		$27,631

STREET RAILWAY DEPARTMENT

Gross revenue	$288,724	
Operating expenses	$190,956	
Gross gain		$97,768

If we take the utilities individually, the gross revenue would show a good return on the amount invested, with the exception of the water-works, as follows: Street railway, 10½%; electrical, 16%; telephone, 6½%; water-works, 1¼%.

The water-works department is under heavy expenditure just now for a new pump-house, intake and force mains, from which there will be no revenue until next year, when this department will show up to much better advantage.

That the consumer's rates at Port Arthur compare favorably with those in other cities, Mr. Hackney thinks is borne out by the following:

STREET RAILWAY DEPARTMENT—Tickets, 8 for 25c. and 6 for 25c.

ELECTRICAL DEPARTMENT—Domestic: 4c. per 100 ft. area charge plus 2½c. per kw.-hr., less 10 per cent. Commercial: 6c. for the first hour's daily use of installed capacity, 2½c. for all above, less 10 per cent. Power: Unrestricted power, $25 per hp. per annum for 24-hr. power, $20 per hp. per annum for 10-hr. power.

Metered power—A. C. service charge of $1 per hp. per month, and a consumption charge of

1.3c. per kw.hr. for the first 50 hr. monthly use of maximum demand.

0.9c. per kw.hr. for all additional consumption up to the second 50 hr. monthly use, and

0.1c. per kw.hr. for all remaining consumption.

Metered power—D. C. service charge of $1 per hp. per month, and a consumption charge of

1.5c. per kw.hr. for the first 50 hr. monthly use of maximum demand.

1.0c. per kw.hr. for all additional consumption up to the second 50 hr. monthly use, and

0.15c. per kw.hr. for all remaining consumption.

TELEPHONE DEPARTMENT—Residence party line, $12 per yr.; residence single line, $15 per yr.; commercial, $30 per yr.

WATER DEPARTMENT—10c. per 100 cu.ft. for the first 1000 cu.ft., and then 7c. per 100 ft. for all above, plus meter rent.

The Production of Sand and Gravel in the United States in 1812, reported to the U. S. Geological Survey by Ralph W. Stone, was 68,318,877 short tons, valued at $23,081,555, as compared with 66,846,959 tons in 1911, a net increase of 1,471,918 tons. Sand for building purposes constitutes about ⅓ of the total production. In 1912, 23,632,157 tons of building sand were produced, valued at $7,904,321, as compared with 24,614,342 tons, valued at $7,719,286 in 1911, a decrease in production of 1,082,185 tons, and an increase in value of $185,035. The average value of building sand per ton increased from 31c. in 1911 to 33⅓c. in 1912. Mr. Stone attributes this condition to the higher wages paid to laborers.

The tonnage of gravel produced exceeds that of sand. In 1911 nearly 30,000,000 tons of gravel for concrete paving, filter beds, roofing, road-making, railway ballast, etc., was produced, as against about 26,600,000 tons in 1911. The increase in average cost per ton of gravel was from 25c. to 26c. Mr. Stone says that although wages paid to laborers have probably increased and tended to raise the cost of gravel he believes that the introduction of machinery during 1912 tended to reduce the average cost per ton.

The heaviest building-sand producer in 1912 was New York, which produced 4,125,271 tons. Next in order, all exceeding 1,000,000-tons production, were the following states: Illinois, Missouri, Pennsylvania, Ohio, Indiana, New Jersey and Iowa. The greatest gravel-producing state in 1912 was Illinois with 3,481,638 tons. Next in order, all exceeding 2,000,000 tons capacity, were Ohio, Indiana and New York.

Street Damage from a Sewer Collapse, Newark*

By Edward S. Rankin†

Shortly after midnight on July 7, during a heavy downpour of rain, a section of the sewer on Bank St., Newark, N. J., between High and Plain Sts., about 20 ft. in length, collapsed, completely blocking the flow and backing up the water through a manhole, to the surface of the street.

The street has a steep grade, approximately 7%, and was paved less than a year ago with grouted granite on a concrete base. The sewer, built of brick in 1871, parallels the surface at a depth of about 13 ft. It is egg-shaped, 3x4.5 ft., and was constructed in a rock cut. Apparently, no care had been taken to properly fill the voids between the rock and the masonry. The sewer theoretically is large enough to care for the storm water tributary to it during the heaviest rainfalls and no complaints have ever

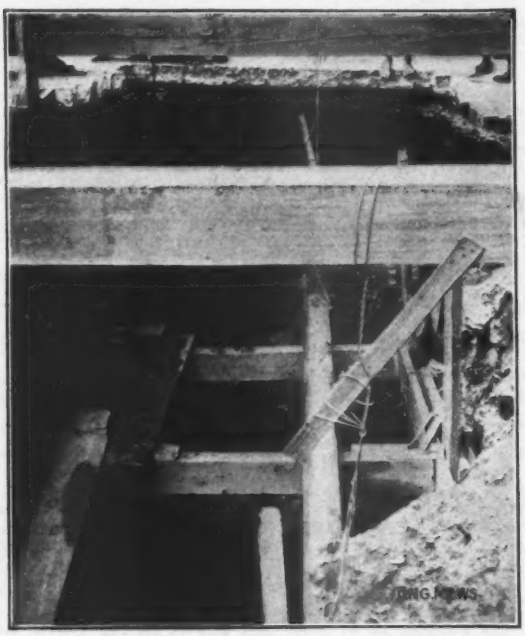


Fig. 1. Large Hole in Bank St. at Point of Sewer Collapse

(The brick sewer is 13 ft. below street level. The cast-iron water main shown was not damaged.)

been received of flooding in this section, although much heavier rainfalls have been experienced.

The rising water somehow found its way between the concrete foundation of the pavement and the granite blocks, and the latter being absolutely water-tight were lifted bodily from the foundation by the head of water caused by the steep grade of the street. The pavement for a distance of 300 ft. is more or less raised and cracked and in three places, about equal distances apart, badly ruptured. The upper and middle breaks take the form of transverse arches with a span of about 13 ft., and a rise of 18 in. At the lowest break, a section of the pavement about 3x8 ft. was lifted completely from its bed and thrown several feet from its original position.

While the breaking of the sewer was undoubtedly the primary cause of the trouble, it is impossible to determine

Fig. 2. Bulged Granite-Block Pavement

(Pavement was laid by the Hildreth Granite Co. in July, 1913. The 5-in. blocks were laid on a 1½-in. sand bedding on a 6-in. concrete bed of 1:3:5 mixture, which rested on rolled earth. The blocks were grouted with a 1:1 mixture. When the blocks were laid they were first flushed with very wet grout; then grout of creamy consistency was worked in between the joints. The whole was allowed to set for seven days and kept wet meanwhile.)

positively how this break could have damaged the pavement to such an extent. It seems probable, however, that the water escaped through loosely laid brick at the top of the manhole immediately below the cast-iron head, as a number of brick were found to be washed out at this point. The entire pavement for a distance of 300 ft. will probably have to be relaid, although it is believed that most of the concrete foundation will be found intact.

*The views in this article were furnished by the Hildreth Granite Co., 290 Broadway, New York City, who laid the pavement on Bank St., Newark.

†Engineer, Department of Sewers and Drainage, Newark, N. J.

The Report of the Commission of Inquiry on the "Empress of Ireland" Disaster

We briefly summarized in our last week's issue that part of the report of the "Empress of Ireland" Commission which dealt with the placing of the blame for the collision between the "Empress of Ireland" and the "Storstad." A part of the report which is of greater engineering interest deals with the question why the "Empress of Ireland" sank in so short a time after receiving the fatal wound.

The "Empress of Ireland" was a comparatively new vessel. She was built in 1906 to class 100 A1 at Lloyds. She had four complete steel decks running from stem to stern; the shelter deck, upper deck, main deck and lower deck. The upper deck was at its lowest point 21 ft. above the water line.

There were ten transverse water-tight bulkheads terminating in each case at the upper deck. These bulkheads were built in accordance with the recommendation of the British Board of Trade Bulkhead Committee of 1891. They were designed in accordance with recommendations of that committee so that any two adjacent compartments might be flooded without sinking the ship below the margin of safety line drawn below the upper deck. Twenty-four water-tight doors in these transverse bulkheads were of the horizontal sliding type, opened and closed by hand. All these doors appear to have been open at the time of the collision and the board concluded after hearing the evidence that nearly all the water-tight doors

on the starboard side between the main and upper decks remained open after the collision. A large proportion of the porthole openings in the side of the ship were also open when the collision occurred.

The stem of the "Storstad" penetrated the side of the "Empress of Ireland" some 21 ft., making a hole about 46 ft. in height, about 25 ft. of which was below water. The width of the hole it is impossible to ascertain, as there may have been some longitudinal ripping action as well as the direct contact. The commission concludes, however, that when the bow of the "Storstad" was withdrawn from the side of the "Empress," an area of no less than 350 sq.ft. was opened for the access of water to the hull.

The collision occurred in the immediate vicinity of the water-tight bulkhead between the two boiler rooms; hence these compartments with a combined length of 175 ft. were at once placed in communication with the sea. With both these compartments flooded the vessel would be sunk practically 9 ft. and if she remained on an even keel without listing, this would take the main deck 4 ft. below water amidships. She would still have had a metacentric height of just over 2 ft., however, and would have continued to float upright had the water-tight doors in the bulkhead above the main deck on either side of the flooded compartments been closed. With the water-tight doors open, however, water from the flooded compartments immediately entered the compartments adjoining. The reason for the great listing of the vessel was that the flooded boiler rooms were divided longitudinally by a coal bunker, steam-pipe passages, etc., which, while not by any means water-tight, considerably delayed the flow of the water from the starboard side to the port side. The commission concludes that the ship probably listed some 15 to 20°; and deep in the water as she was from the flooded boiler compartments, this would cause the water to pour in all along the starboard side of the vessel at the open port holes.

Conclusions

At the close of its report, the commission makes the following suggestions:

1. In order to prevent, if possible, disasters such as that into which we have been inquiring, we think that in foggy weather it would be desirable to close all watertight doors and port holes below the top of the watertight bulkheads, and to keep them closed until the fog has completely cleared. We think, also, that wherever practicable all watertight doors and portholes below the above level should be closed at sunset and kept closed until sunrise.

Precautions of the kind suggested would have the effect of securing the floatability of the ship in accordance with the intentions of the designer, whereas neglect of such precautions may lead to the foundering of a vessel which would otherwise have remained afloat.

2. The rapidity with which the vessel foundered after the collision made the life saving appliances on board of little use. Most, if not all, of the passengers were in bed when the vessel was struck, and there was an interval of only about fifteen minutes between the collision and the foundering. The list which the vessel took to starboard was so sudden and so great that the lifeboats on the port side were rendered useless almost at once. Some of them were indeed worse than useless, for they broke adrift and injured people as they clattered down the sloping deck. Of those on the starboard side, six only were launched, although the best was done in the short time available to get them into the water. These circumstances lead us to suggest that it might be desirable to consider whether rafts could not be placed in such a position on the upper deck that they would float automatically on the water as the ship sank. Such rafts would doubtless have to be attached to the deck in such a way as to prevent them from getting adrift in bad weather; but the attachments might be of a simple kind which could be loosened in a very short time.

NEWS NOTES

The Boiler of a Steam-Shovel Engine exploded at Wrenshall, Minn., on July 16, killing one man.

The Walls of a Frame Church Collapsed near Mount Vernon, Ark., on July 6. There was no one in the building at the time.

The Steamship "Mendoza" Went Ashore in a fog off Mogotes Point on the Argentine coast, on July 11. The "Mendoza" is a vessel of 2856 tons, belonging to the Hamburg-South American Steamship Co. She was built in 1894.

A Traction Engine Went Off a Dock at Glenwood, L. I., on July 18, when the engineer lost control. The engine was used in transporting sand to Roslyn. A derrick at a sand bank on the opposite shore lifted the engine from the channel without difficulty.

A Sewer Cave-In Laid to Rats—A 4-ft. brick sewer on Liberty St., between Broad and Nassau St., New York City, collapsed on July 20, shortly after 5 p.m. The cause of the collapse is said to have been the water rats gnawing at the mortar between the bricks.

A Cloudburst in Raleigh, N. C., caused considerable damage on July 14. The Carolina Power & Light Co.'s plant was shut down, and the basements of printeries were flooded to a maximum depth of 6 ft. The rainfall is reported at 3.4 in. in one hour, the heaviest in Raleigh in 26 years.

A Cave-In in the Balkan Mine at the Alpha location, near Iron River, Mich., on July 15, caused by quicksand, killed seven miners. The miners were drilling into a roof when the drill hit quicksand. The gang, about 30 in number, rushed toward the mouth of the tunnel. The mine was filled by the sand.

A Railway Collision between an electric excursion train and a Virginian Ry. freight train at a grade crossing near Norfolk, Va., on July 17, killed six persons. Press dispatches state that the crossing gates were down, and that the electric train crashed through these gates before striking the freight.

A Cloudburst in Bull Run, Penn., on July 15, moved 20 houses from their foundations, sweeping several into the Susquehanna River. A mill and a cigar factory were destroyed, as were the roads in the vicinity of the town. Bridges were washed away, and it is said that the fields were under 10 ft. of water.

A Suspension Bridge Over the Merrimac River Was Blown Over in a severe electric storm which swept a portion of the Merrimac Valley on July 12. The bridge was located at Tyngs Island. It was built by the Vesper Country Club six years ago, and cost $5000. It failed by breaking in two. The abutments on each side are intact.

A Street Car Fell Off a Viaduct at Superior, Minn., on July 9. According to press dispatches, the car was coming down the slope of the east portion of the viaduct when it jumped the track, crashed through the rail and dropped near the railway tracks underneath. The speed was moderate and the brakes set when the derailment occurred. There were no fatalities.

A Building Wall Collapsed in Northampton, Mass., on July 18, severely injuring one person. The damaged building is known as Union Block, and fronts upon Main St. The building houses several stores and lodge rooms. There were more than 100 people inside at the time, but the sound of cracking timbers gave sufficient warning for most of them to escape without injury.

A Heavy Rainstorm in Philadelphia on the afternoon of July 15, tore holes in pavements, flooded cellars, and interrupted street-car traffic. On Thompson St. a sewer caved in. A deep cut on the Philadelphia & Reading Ry. between Fennsdale and Roxborough was filled with 4 ft. of soft sand and debris. The official rainfall figure was 0.61 in. in 15 minutes, but in Manayunk, where the greatest flood damage is reported measurements taken by Supt. Winfield Guile of the Manayunk Canal are said to show a precipitation of 2 in. in 20 minutes.

A Severe Wind Storm, with rain and hail, struck Henderson, Ky., on July 16, about 5:30 p.m. Several buildings were wrecked, roofs blown off, trees blown down, and much miscellaneous damage done. The municipal electric light plant was struck by lightning, while the rear end of the building was

knocked down and the roof blown off. The street and interurban electric car lines were put out of service for some hours, due to crossed wires and damage to the overhead work. One building was burned as a result of crossed wires. Two persons were killed in a residence which was crushed by an adjacent building being blown over upon it.

Municipal Docks at Trenton, N. J., are to be started with the construction of the new pier on the Delaware River at the foot of Federal St., the plans and specifications for which have just been approved by the city authorities. It is to be 225 by 500 ft. in area and will cost about $50,000.

Engineering Activity on the West Coast—More than 2000 applications have been received by the City Engineer of San Francisco, Calif., for employment on the engineering staff for the Hetch-Hetchy municipal water supply project. ["Western Engineering," July, 1914.]

Tunnels Named for Engineers are to be a feature of the Magnolia cut-off line which the Baltimore & Ohio R.R. is building between Orleans and Little Cacapon, W. Va., 11 miles. The four tunnels will be named for four of the road's chief engineers, as follows: James L. Randolph (1863-1883), J. M. Graham (1899-1904), D. D. Carothers (1904-1911), and Francis Lee Stuart (1911 to the present time). The new line shortens the distance by six miles and extends the four-track system east of Cumberland.

Commercial Attaches May Be Appointed for the principal United States legations in foreign countries, according to plans of the Department of Commerce. It is proposed to have connected with each important legation a man of good business experience who will be competent to give advice in all cases in which matters come up affecting his country's commercial relations, and who will be able to make himself generally useful in promoting the commercial interest of the United States in the country to which he is accredited.

Concrete Road Construction Statistics—According to statistics gathered by the California State Highway Commission three times as much concrete was laid on roads and streets in California during 1913 as in any other state. The amount laid last year was 1,766,000 sq.yd. in California, while the country's total was 8,093,360 sq.yd. Ohio was second with 655,650 sq.yd. The total amount of concrete roads and streets laid up to Jan. 1, 1914, in the United States amounted to 18,436,016 sq.yd., of which California is credited with 1,979,000 sq.yd. New York leads in present construction work with a total of 2,402,785 sq.yd.

A New German Canal from Berlin to Stettin, on the North Sea, was officially opened on June 17, and has been named the Hohenzollern Canal. The length of the canal from Berlin to its junction with the Oder River is about 60 mi. The canal is shallow, the vessels plying upon it having a draught of only 5½ ft., but by using a length of 214 ft. and a width of 26 ft. a cargo of 600 tons can be carried. The cost of the canal has been about $12,000,000, and it is estimated that for several years there will be a deficit in its operating expenses of about $125,000 per annum. This will not be charged to the national treasury, however, but will be met by the cities of Berlin, Charlottenburg, and Stettin.

A 16-in. Gun, constructed at Watervliet arsenal, was recently shipped to the Panama Canal fortifications, after tests at the Sandy Hook proving ground. The gun is 50 ft. long, weighs 142 tons, and fires a projectile about 6 ft. long. The projectile itself weighs a ton, and is discharged by 665 lb. of powder. Eight men are required to handle the powder charge. The gun has a maximum range of about 22 miles. Upon discharge the shell is revolving about its axis at about 4000 r.p.m. The gun pressure is 38,000 lb. per sq.in. The muzzle velocity is 2250 ft. per second, and the muzzle energy more than 84,000 ft. tons. The carriage for this gun is now under construction at the Watertown, Mass., arsenal, and will probably not be shipped to Panama until next spring.

First Decision under New York's New Liability Law—The Workmen's Compensation Commission in its first public hearing on July 20, rendered a decision on the first claim to be brought to the attention of the Commission. This claim was presented by the widow of an employee on the new Equitable Building on Broadway, who was killed by falling on July 1, the day the new law became effective. This workman received $5 per day and earned an average wage of $25 per week. The Commission awarded the widow $30 per month, or 30 per cent. of her husband's monthly wage, to which she was entitled under the law. She will receive this throughout her life, unless she remarries. In addition to this the Commission awarded her child $10 a month until the child reaches the age of 18.

Awards Have Been Made in the Competition of the Barber Asphalt Paving Co. (noted in "Engineering News," Mar. 12, 1914, p. 586), for papers from engineering students on the subject of asphaltic materials for highway construction. The following students were awarded prizes of $100 each: Frederic O. X. McLoughlin, Columbia University; Henry Schindler, Cornell University; B. J. Fletcher, University of Georgia; John W. Hill, University of Illinois; Robert S. Johnson, Iowa State College; M. V. Holmes, University of Kansas; F. P. Gilbert, Massachusetts Institute of Technology; Harold J. LaLonde, University of Michigan; Benjamin Wolk, University of Minnesota; Alvin C. Smith, University of Nebraska; O. H. Gosswein, Purdue University; Alfred A. Bertowitz, Sheffield Scientific School; W. J. Campbell, Syracuse University.

The Power Plant, Substation and Transmission Line of the Truckee-Carson irrigation project will be leased by the U. S. Reclamation Service for ten years to the Canyon Power Co., of Oakland, Calif. This is subject to power sales already made. The bid of the Canyon Power Co. is at the rate of ¼c. per kw.-hr. for the excess power during the summer months (April to September, inclusive), and at the rate of ⅜c. from October to March, inclusive. There is to be a minimum payment of $1200 per month during the summer months. The net income to be expected is approximately $14,000 per annum as a minimum, with a possible maximum of approximately $30,000 per annum; the more probable figures are about $20,000 per annum. A stipulation will be inserted in the contract for the protection of small consumers by limiting the price to be charged.

The Compensation of Railway Labor in the United States and in England was compared in an interesting statement issued by the Bureau of Railway News and Statistics. According to the British Board of Trade, there were 643,135 wage earners employed on the railways of Great Britain on Dec. 31, 1913. Of these 594,088 were classed as adults, and 49,047 as boys (i.e. under 18 years of age). The total is 44,385 more than in 1910, but only 21,794 over the number reported in 1907. The salaried staff is not included in the figures. In the United States, in 1913, the total was 1,714,603, also exclusive of officers. The compensation of British railway employees between 1901 and 1912, from available figures, increased from $146,000,000 to approximately $175,000,000—about 19%. The number of workers, however, increased only 11%. During the same period, compensation of American railway employees, exclusive of officers, increased from $588,000,000 to $1,228,000,000, or 108.5%, against an increase of 61.5% in the number of workers. The average pay of British railway employees in 1901 was about $255 per year, and in 1912 $271; American employees in 1901 received $555 each and in 1912, $716 each.

The Morris Dam of the Waterbury, Conn., Water-Works, described in detail in "Engineering News," Mar. 23, 1911, is now complete with all its appurtenances. There is a 90-ft. earth dam with a concrete core-wall; one of the largest structures of the kind in the Eastern States. The quantities in the completed dam are as follows: 46,039 cu.yd. earth excavation, 9603 cu.yd. rock excavation, 520,304 cu.yd. rolled embankment, 13,206 cu.yd. loaming, 39,457 cu.yd. concrete masonry, 3203 cu.yd. concrete blocks, 601 cu.yd. rubble masonry, 369 sq.yd. granolithic finish, 11,543 cu.yd. paving (including brook channel), 171 cu.yd. rip-rap, 6367 cu.yd. broken stone, 362 lin.ft. 12-in. vitrified tile pipe, 344 lin.ft. of 8-in. vitrified tile pipe, 8 catch basins, 21,000 ft. b.m. lumber in temporary dam), 4812 sq.ft. steel sheet piling, 118,012 lb. steel reinforcement, 53,107 bbl. cement, 1 drain gate house, 1 service gate house.

Especial care was taken with foundations. Running the entire length of the dam, which is 1125 ft. over all, masonry was started in the bottom of the trenches cut into solid ledge, after the surface had been cleaned and washed with water and wire brushes and every particle of loose rock or dirt removed. In the construction of the earthwork remarkably good material was available. All masonry is of concrete. The cement was at all times satisfactory. Sand was obtained near at hand and after washing was given a mechanical analysis, samples being taken at regular intervals. Stone was obtained from a quarry just west of the dam and was found of good quality, except for the presence of a considerable amount of mica. Concrete mixtures were varied according to location of the masonry, from 1:3:6 to 1:2:4 proportions. The richer mixtures were used in construction of concrete blocks, which form the exposed surfaces of all walls, and in the thinner portions of the walls, where impervious masonry was important. R. A. Cairns is City Engineer of Waterbury, from whose recent report the data quoted were taken.

No Proposals For Bonds, to be issued by the city and county of Denver to the amount of $8,000,000, for construction

of new municipal water-works (as outlined in "Engineering News," July 2, 1914) were received by the Public Utilities Commission on July 20 when bids were to have been opened. The failure to receive bids is construed by the Utilities Commission as due to the opposition of bond houses, owing to the fact that $12,000,000 in bonds of the Denver Union Water Co. are now outstanding and no provision was made for their redemption in bonds of this issue (rather than as being reflection on the credit of the city). It is reported that a number of bond houses have signified their desire to purchase the bonds, provided the bonds of the water company are taken care of. Several informal offers of reservoirs, reservoir sites, irrigation works, and even covering the construction of a new plant in return for bonds have been received but have not been acted upon.

The Cucaracha Slide on the Panama Canal appears about to finally yield to the continued assaults upon it. Ever since water was admitted to the cut, dredges have been at work at the toe of the slide, endeavoring to excavate the earth and rock as fast as it flows in. As is generally known, this slide consists of a huge blanket of clay, covering originally some 47 acres, which is gradually moving down the hillside on the sloping bed rock like a huge glacier. The surface of the slide from the top to the bottom has the appearance of a series of waves, caused by the formation of the underlying rock over which the slide is moving. As much of the rock is soft and the pressure of the earth is great, a considerable amount of the rock has broken off and added its volume to the slide. For a considerable time, a navigable channel has been maintained past the slide, and there is now depth and width sufficient for ships to pass with a draught of 25 ft. The ladder dredge "Corozal" is now at work deepening this channel to the full depth. The movement of the slide has lessened of late. On July 20, 4800 lb. of 60% dynamite carried on the drill barge "Teredo" prematurely exploded, killing five men and injuring 18. Eight drill holes in the slide had just been charged when the explosion occurred.

A Report on the Panama Canal, both comprehensive and concise, will be a part of the proceedings of the International Engineering Congress to be held at the Panama-Pacific International Exposition, San Francisco, Calif., Sept. 20-25, 1915. Col. Goethals is chairman of the Congress and is to open the discussion on the Canal, which will be divided into the following heads:

(1) Col. Goethals' general report, (2) Dry excavation of the Panama canal by Col. Goethals, (3) Dredging the canal; (4) Terminal works, dry docks and wharves of the canal; (5) Meteorology and hydrology of the zone; (8) Designs of locks, dams and regulating works; (9) Methods of construction of same on the Atlantic side; (10) Same on the Pacific side; (11) Designs of locks walls and valves; (12) Spillways; (13) Gates of the canal; (14) Electrical and mechanical installation; (15) Emergency dams above locks; (16) Municipal engineering and domestic water supply in the zone; (17) Reconstruction of the Panama railroad; (18) Aids to navigation of the canal; (19) Geology of the canal zone; (20) The working force of the canal;(21) Sanitation in the zone; (22) Purchase of supplies for the canal.

Following Colonel Goethals' personal reports, each of these topics will be treated by the heads of departments or other attaches who were responsible for that part of the canal construction.

PERSONALS

Mr. George F. Baker, formerly with the Morgan Engineering Co., of Memphis, Tenn., has been appointed Assistant City Engineer of Dayton, Ohio.

Dr. Charles W. Berry, a physician of Brooklyn, N. Y., has been appointed Sanitary Supervisor of the New York State Department of Health, at a salary of $4000 per annum.

Mr. J. W. Carnes, recently Trainmaster of the Trinity & Brazos Valley Ry., at Teague, Tex., has been promoted to be Assistant General Superintendent, with headquarters at Teague.

Mr. F. K. Zook, former Engineer of Maintenance-of-way of the Northwestern Pacific R.R., has been promoted to be Chief Engineer of Maintenance and Structural Engineer of the railway.

Mr. Ross S. Marshall, formerly Superintendent of the Minneapolis & St. Louis R.R., at Oskaloosa, Wis., has been appointed Division Superintendent of the Seaboard Air Line Ry., at Richmond, Va.

Mr. H. B. Grimshaw, former Superintendent of the Seaboard Air Line Ry., at Americus, Ga., has been appointed General Manager of the Macon, Dublin & Savannah R.R., with offices at Macon, Ga.

Mr. William Bacon Gray, Assoc. M. Am. Soc. C. E., formerly General Superintendent of S. Pearson & Son, Inc., has opened an office for the general practice of civil engineering at 2 Rector St., New York City.

Mr. Samuel Wilson has resigned his position with the American City Bureau, New York City, and has been elected Secretary of the Chamber of Commerce of Johnstown, Penn., at a salary of $3600 per annum.

Mr. R. C. Watts, formerly in the employ of the New York, Chicago & St. Louis R.R., on grade elimination work in Cleveland, Ohio, has accepted a position in charge of equipment of the State Highway Department at Columbus, Ohio.

Mr. J. S. Calhoun, Jr., recently Sub-Inspector, Department of Public Works, Charleston, S. C., Navy Yard, has been appointed Superintendent of J. F. Jenkins & Co., of Osceola, Fla., contractors for the United States Post Office at La Fayette, La.

Mr. P. C. McArdle, Assistant State Highway Engineer of Illinois, has been appointed Acting Chief State Highway Engineer, to succeed Mr. A. N. Johnson, M. Am. Soc. C. E., resigned, as noted in our issue of June 25, to become connected with the Bureau of Municipal Research, New York City.

Mr. Frederick O. Ball, M. Am. Soc. M. E., has resigned as General Manager of the American Engine & Electric Co. (formerly the American Engine Co.), of Bound Brook, N. J., to engage in the manufacture of carburetors with his father, Mr. Frank H. Ball, M. Am. Soc. M. E., under the firm name of Ball & Ball, Detroit, Mich.

Mr. D. Howard Martin, M. Am. Soc. C. E., recently Division Engineer of the Pittsburgh & Shawmut R.R., Brookville, Penn., has been appointed Chief Engineer of James H. Corbett & Sons, Kittanning, Penn., contractors for Section 5 of the new Welland Ship Canal, with headquarters at Allanburg, Ont. The company is also engaged on railway construction contracts in the United States and Canada.

Mr. J. W. Williams, former Assistant Chief Engineer of the Northwestern Pacific R.R., has been appointed Chief Engineer of Construction to succeed Mr. William C. Edes, M. Am. Soc. C. E., now a member of the Alaska Engineering Commission. Mr. Williams is a native of Milan, Ohio, and has been in railway engineering work since 1901, when he was employed on the Santa Fé Central Ry. as chainman, levelman and transitman. He has been Assistant Chief Engineer of the Northwestern Pacific since 1907.

Mr. J. R. Bibbins, associated with Mr. Bion J. Arnold, M. Am. Soc. C. E., Consulting Engineer, Chicago, has been engaged by the law department of the city of Pittsburgh, Penn., in an advisory capacity in connection with the improvement of local transportation facilities. An attempt will be made, in coöperation with the street-railway company, for an operative service standard, for scientific rerouting in the terminal district and for progressive rehabilitation of the property. Mr. Bibbins was Resident Engineer for Mr. Arnold on the investigation of transit problems in Providence and San Francisco.

Mr. Joseph Bucklin Bishop, Secretary of the Isthmian Canal Commission since September, 1905, has resigned, as his work at Panama has been completed. Mr. Bishop founded and edited the "Canal Record," and is well known to many engineer visitors to the Canal Zone. Previous to entering the Canal Service he was for 35 years engaged in newspaper work in New York City, chiefly as an editorial writer with the "Tribune" and the "Evening Post." Mr. Bishop has entered a contract with Charles Scribner's Sons, publishers, New York City, for literary work in connection with their magazine and publication department.

Mr. Etienne Pelland, former Engineer in charge of the sewer department of Montreal, Que., has been arrested on charges of alleged graft in connection with the construction of the Notre Dame de Grace sewer. According to the Montreal "Gazette,"

It is alleged that during the period between January and April, 1914, with intent to defraud the city of Montreal by false pretences, Mr. Pelland illegally, unlawfully and fraudulently procured, and caused to be procured at various times, various sums of money, in all amounting to about $75,000, to various persons, by making false reports and causing to be made false plans and profiles of a sewer to falsely and fraudulently represent rock at certain elevations.

Mr. George M. Lehman, M. Am. Soc. C. E., Engineer in Charge of the Pittsburgh Flood Commission work, Pittsburgh, Penn., has been appointed Chief Engineer of the Lake Erie & Ohio Canal Board, recently appointed by Gov. Tener,

of Pennsylvania. The members of the Board are: President, Mr. William A. Magee, former Mayor of Pittsburgh; Col. Thomas W. Symonds, Corps of Engineers, U. S. A., retired; Mr. Tom P. Sloan, of Lock No. 4, Washington County, Penn.; Messrs. James A. Chambers and A. S. McSwigan, of Pittsburgh, Penn. Offices have been opened in the Farmers Bank Bldg., Pittsburgh, and the fieldwork of surveying has been begun.

Messrs. George T. Seabury and Albert A. Northrop, M.'s Am. Soc. C. E., announce the formation of the firm of Seabury & Northrop, Inc., Consulting and Construction Engineers, 101 Park Ave., New York City. Mr. Seabury is a graduate of the Massachusetts Institute of Technology, class of 1902, and received his early engineering experience with the contracting firms of J. C. Rodgers and John F. O'Rourke. For the past eight years he has been connected with the Board of Water Supply of the City of New York, engaged upon the preliminary investigations of the Olive Bridge dam; later as one of the two personal Assistants to the Chief Engineer, and for the last four years as Assistant to the Division Engineer, in charge of constructing the Kensico dam and that portion of the Catskill aqueduct, including the complicated Control Works at the Kensico reservoir. Mr. Northrop is a graduate of New York University, class of 1900, and his early experience was in railroad construction and maintenance. He was in direct charge of the construction of the Olive Bridge dam of the Ashokan reservoir for the Board of Water Supply, and for the last four years has been associated with Mr. John R. Freeman, M. Am. Soc. C. E., Consulting Engineer, of Providence, R. I. For Mr. Freeman, he has had charge of the construction of the Holter dam across the Missouri, in Montana, of estimates and reports upon the various hydro-electric developments, and was Auditing Engineer on the construction of the hydraulic features of the Mississippi River Power Co., at Keokuk, Iowa. The new firm will specialize in the investigation of hydroelectric developments and the supervision of general construction.

Mr. Alfred Douglas Flinn, M. Am. Soc. C. E., Department Engineer of the Board of Water Supply of the City of New York, has been promoted to be Deputy Chief Engineer, succeeding Mr. Merritt H. Smith, M. Am. Soc. C. E., resigned, to become Chief Engineer of the Department of Water Supply, Gas and Electricity, as noted in our personal columns of July 9. Mr. Flinn was born in Pennsylvania in 1869 and graduated in civil engineering at the Worcester Polytechnic Institute in 1893. From 1893 to 1895 he was connected with the distribution department of the Boston, Mass., waterworks, under Mr. Dexter Brackett, M. Am. Soc. C. E., Chief Engineer. From August, 1895, until October, 1902, Mr. Flinn was with the Metropolitan Water Commission of Boston, first as a transitman and Assistant Engineer on surveys, and later on design and construction of various parts of the Metropolitan water-works. From 1902 to 1904 he was Managing Editor of the "Engineering Record." Mr. Flinn first became connected with the New York City water-works in August, 1904, as General Inspector of the Croton Aqueduct Commission. On the establishment of the Board of Water Supply's engineering department in 1905, to make and carry out plans for the Catskill water supply, Mr. Flinn was appointed Department Engineer in charge of the headquarters department, where he had supervision of the preparation of all important designs, the preparation of contracts and specifications, the inspection of materials, researches and investigations, annual and other reports, organization and general executive matters relating to the engineering bureau. The appointment is effective Aug. 1 and carries a salary of $9000 per annum.

OBITUARY

Henry R. Emmerson, former Minister of Railways and Canals of Canada, died July 9 at his home in Dorchester, N. B.

Robert Strathearn, a civil engineer employed by the sewer department of Toronto, Ont., was asphyxiated by illuminating gas while making survey measurements in the Argyle St. sewer tunnel, Toronto, July 7.

Alanson Harvey Green, for many years Professor of mathematics at the Brooklyn Polytechnic Institute, died July 14, at his home in Brooklyn, N. Y. He was born in 1841. He retired from the faculty of the Institute in 1898.

George Stewart, for many years Civil Engineer of the American Coal Products Co., died July 15, at the home of his son, George F. Stewart, a contractor, of Brooklyn, N. Y. The elder Mr. Stewart was born in England 74 years ago.

Samuel F. Prince, Jr., formerly Superintendent of motive power and rolling equipment of the Philadelphia & Reading Ry., died in New York City, July 13. He resigned from the railway company in 1904 to accept a position with the Nilson Bement-Pond Co., New York City. He was 62 years old.

Kurt W. Peuckert, of the firm of Peuckert & Wunder, Architects and Engineers, Philadelphia, Penn., died July 21, at his home at Sharon Hill, Penn. He was born in Germany 66 years ago, and came to this country at an early age. He was a member of the Franklin Institute and many fraternal societies. He is survived by a widow and one daughter.

Dr. William Bleecker Potter, M. Am. Inst. M. E., Mining Engineer and Metallurgist, founder and Manager of the St. Louis Sampling & Testing Works, St. Louis, Mo., died July 14, aged 68 years. He was a son of Bishop Horatio Potter and a nephew of the late Bishop Henry C. Potter, of New York City. He was born at Schnectady, N. Y., in 1846, and graduated from Columbia University in 1866. In 1869 he received the degree of Mining Engineer at Columbia. For a few years he was Assistant in geology at Columbia, and then was Professor of mining and metallurgy at Washington University, St. Louis, Mo., until 1893, when he founded the St. Louis Sampling & Testing Works.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN ASSOCIATION OF RAILROAD SUPERINTENDENTS.
Aug. 20-21. Annual meeting in New York City. Secy., H. Harman, Room 101, Union Station, St. Louis, Mo.

AMERICAN PEAT SOCIETY.
Aug. 20-22. Annual meeting at Duluth, Minn. Secy., Bordollo, 17 Battery Place, New York City.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION.
Sept. 1-4. Annual convention in New York City. Secy., J. D. Farasey, E. 37th St., and Erie Ry., Cleveland, Ohio.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 7-10. Annual meeting in New York City. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

NATIONAL ASSOCIATION OF PORT AUTHORITIES.
Sept. 8-10. Annual convention in Baltimore, Md. Secy., Wm. Joshua Barney, 29 Broadway, New York City.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 8-11. Annual meeting at Chicago, Ill. Secy., L. C. Ryan, Sterling, Ill.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 8-11. Annual convention in Nashville, Tenn. Secy., A. P. Dane, Reading, Mass.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 9-11. Annual convention in Boston, Mass. Secy., Willard Kent, Narragansett Pier, R. I.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 15-18. Convention in Atlantic City, N. J. Secy., Clayton W. Pike, Electrical Bureau, Philadelphia, Penn.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 21-25. Annual convention in Cleveland, Ohio. Secy., Joseph D. Israel, 29 W. 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Sept. 22-24. Annual convention in Bluff Point, N. Y. Secy., C. C. Rosenberg, Times Building, Bethlehem, Penn.

American Society of Agricultural Engineers—The committee on farm structures of the American Society of Agricultural Engineers, the chairman of which is E. S. Fowler, Security Bank Bldg., Minneapolis, Minn., is making a study of the most economical and convenient designs for farm buildings, etc. The results of the study will be reported at the next convention of the Society, to be held in Chicago, next December.

American Boiler Manufacturers' Association—The 26th annual convention will be held in New York City, Sept. 1-4, with headquarters at the Waldorf-Astoria Hotel. All boiler, tank, and stack manufacturers, and fabricators of steel plates, also manufacturers of materials and supplies used by boiler manufacturers, are invited to attend this convention. Among the important subjects to be discussed is that of uniform boiler specifications. The secretary is F. B. Slocum, West and Calyer Sts., Brooklyn, N. Y.

International Street Railway and Light Railway Congress—The next meeting will be held at Budapest, Austro-Hungary, Sept. 7 to 10, instead of in August as previously announced. In addition to entertainments during the period of the Congress there will be two alternative excursions of three days each. One of these is north to Tatra, in the Carpathian mountains; the other is south to Arad and Bazias, and then by steamer down the Danube to Orsova. The Secretary of the Congress is H. Camp, 23 Rue d'Arlon, Brussels.